HISTORY OF CHEMISTRY IN ANCIENT TURKS

Hakan ERTUĞRAL

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Hakan ERTUĞRAL

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Prof. Dr. M. Fazıl GÜLER

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master

Prof. Dr. Ahmet TAŞAĞIL

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts.

Prof. Dr. Ahmet TAŞAĞIL

Supervisor

Examining Committee Members

Prof. Dr. Ahmet TAŞAĞIL, Yeditepe Üniversitesi

Prof. Dr. Aydın USTA, Mimar Sinan Güzel Sanatlar Üniversitesi

Dr. Öğretim Üyesi Ahmet BÜYÜKAKSOY, Yeditepe Üniversitesi

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Name, Last name: Hakan Ertürk

Signature:

ABSTRACT

The subject of the study is the chemistry applications of the ancient Turks up to the Uighur state through the development of chemistry within the framework of science and history of science. Firstly, the meaning of science, the limits and the understanding of what is understood as a science, then the special place of chemistry as a field of science and its history is examined, and as a result of the development of the history of the Ancient Turks and the material that today is directly applied to the framework of the application of this science and the material of the people in the past tried to be placed. As a consequence of resources and working conditions, they are specifically used for the purposes of a nomadic-settlement analysis, which is necessary to discuss the construction of a direct linear history. The blacksmithing activities were supported by analyzes such as SEM and EDS, especially through its relations with its neighbors. Information is also given about a number of methods used. The results showed that settlement findings were reached as a result of the isotope analyzes conducted in the regions where Turks lived, and that in the area of blacksmithing, the population and the region could have an impact on the iron production methods as well. More systematic isotope analyzes, SEM and EDS analyzes on the history of the ancient Turks, where the sources seem insufficient, can illuminate a number of issues that remain in the dark.

Key words: *chemistry, AncientTturks, science, history of science, ironrworking*

ÖZET

Çalışmanın konusu, bilim ve bilim tarihi çerçevesi içinde kimyanın gelişimi üzerinden Uygur devletine kadar Kadim Türklerin kimya uygulamalarıdır. Öncelikle bilimin anlamının, sınırlarının ve bilim olarak neyin anlaşıldığının tartışılması, sonrasında bir bilim alanı olarak kimyanın buradaki özel yeri ve kendi tarihi incelenmiş ve sonuçta Eski Türklerin yaşayışlarının da günümüzde geliştirilen ve doğrudan doğruya kimya biliminin konusu ve malzemesi olan uygulamaların katkılarıyla bu halkın geçmişte yaptıkları bir çerçeveye yerleştirilmeye çalışılmıştır. Kaynakların ve çalışma koşullarının bir sonucu olarak özellikle beslenmeleri ki bu doğrudan çizgisel bir tarih inşaasını tartışmak adına gereken bir göçebelik-yerleşiklik çözümlemesi amacıyla kullanılmış, demircilik faaliyetleri de özellikle komşuları ile ilişkileri de üzerinden SEM,EDS gibi analizlerle desteklenilmeye çalışılmıştır. Kullanılan bir takım metotlarla da ilgili bilgiler verilmiştir. Sonuçlar, Türklerin yaşadıkları bölgelerde yapılan izotop analizleri sonucunda yerleşiklik bulgularına ulaşıldığını göstermiş, demircilik alanında ise coğrafyanın ve bölgenin zaman zaman demir üretim yöntemlerine etki ettiği gibi, nüfusun da bu konuda etkisi olabileceğini göstermiştir. Kaynakların yetersiz göründüğü Kadim Türklerin tarihi ile ilgili daha sistematik izotop analizleri, SEM,EDS analizlerinin yapılması, karanlıkta kalan bir takım meseleleri aydınlatabilir.

Anahtar Kelimeler: *Kimya, Eski Türkler, Bilim, Bilim Tarihi, Demircilik*

…to my late grandmother, history teacher Ayten Mugan

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History of the different folk had been formed by following different path according natural causes such as climate or geography. Especially the effect of the some ideas which had a significant domination role these times on people created a view that evaluate the history as a 'developing-progress' process. 19th century, in particularly Colonialism Age, it created 'Eurocentric' view by its own dynamics and understood the whole world with the light of its own.

On the Hegelian influence, History was considered as a progressive process and therefore, nations which had not been developed as well was Europeans, their historical background was judged that they were always behind the Europeans and their different path was related to this situation. This opinion also played a fundamental role for racist behaviors against to undeveloped folks (Bernasconi, 2018, p.11). De Landa argued that formation history of the different folks must be considered as a phase shifts instead of progressive mechanism and their interactive relations must be counted then, for example nomadic modus vivendi, revealed its own mechanism and developed by holding on that mechanism even they settled (De Landa, 2013, p.14-15). Rasonyi pointed out by referring to Raztel and Febre's opinions, blind faith which covered that nomad had a lower degree life-style should have been changed and people must by taking into consideration of primitive modus vivendi was a phenomena seen through sedentary people (Rasonyi, 2002, p.370). Feyerabend said that Eurocentric developing view also affected to their involutory evaluations to assist common opinions (Feyerabend, 1995, p.82). Sinor opposed the view which suggested that idea of people who lived in forest or steppe belts did not have a rudimentary life (Sinor, 2000, p.24). Then, Sinor remarked

that, when the subject was fulfilling the needs, hunters and fisherman must developed improving techniques and produced fine craftsmanship' tools compared to agricultural life then, this complexity which is about gathering people and focused these requirements caused the perfect organization skills for whole people and also gave them applying abilities (Sinor, 2000, p.18). Today, ıt is known that a historic hunter-gatherer folk called Jomon who lived in Japan (Watson, 2015, p.100; Ponting, 2015, p.40) and some South American natives was engaged in agriculture and produced pots and pans (Ponting, 2015, p.40). According to new studies, agriculture did not play a progressive role in humanity alone and it had some disadvantageous which was about gaining more calories for consumers but, its nutritiousness shown the poor qualification on human diet. Malaria was the example for the rising of African agricultural diet and sedentary tendency (Strauss, 2014, p.58). Farming productions was not enough by supplying vitamins and minerals in spite of rise, maize and wheat was able to plant abundantly yet, because of nutritional deficiency, anemia and pellagra could be seen (Pontig, 2015, p.56). According to some analysis about farmers of the Ice Age when they were compared with hunter-gatherers, they suffered from nutritional deficiency, tooth diseases and epidemic illness (Watson, 2015, p.92). Moreover, there was a direct correlation between food production and consumers, when food product increased, consumers who ate them also increased and it leaded to foot shortage and epidemic diseases due to cohabiting (Ponting, 2015, p.56-57). By the way, nomadic people tried to improve some methods to limit their population (Watson, 2015, p.93). Therefore, there were many economic models for people living and agriculture was not the only option (Strauss, 2014, p.58).Farming was not the only path which had to be followed and so that it leaded to form different cultures

all over the World (Strauss, 2016, p.43). It is easy to understand that people who lived on the tracts with their herds and dominated the agricultural basins and improved the trade, could choose omitting being a farmers. Sedentary life can be seen among hunter-gatherers before the agriculture revolution (Watson, 2015, p.95).

German History school which was suggested by Ranke, preferred to value cases in time and also personal instead of timelessness and generalized then, this perspective started to dealing with the positivism which tried to understand cases by using methods of the natural sciences during the second half of the nineteenth century (Özlem, 2016, p.108-109). Christianity affected to way of thinking and formalized the first linear history view (Bumin, 2016, p.11). Anderson stated that, ‘‘Age of Enlightenment brought its own modern obscureness’’ and shifted the religious view with nationalist ideas (Anderson, 2015, p.25). During the nineteenth century, variation was usually considered as a progressive phenomenon however, twentieth century sociologists had certain refusing opinion against this phenomenon and they claimed that these progressive thoughts were just association of some personal and ideological views and that is all (Elias, 2016, p.23). The idea of Evolution which were developed firstly by Anaximander (Adıvar, 2012, p.224) and his student Anaximenes, first animal was created in waters and then it went to highly developed species by keeping its first matter ‘aperion’ (Weber, 2015, p.22) directly affected to civilization view of mankind (Mason, 2013, p.285).

According to Mason, despite the fact that Bronze Age coming first before the Iron Age, ‘barbarians’ who passed the Bronze Age took the advantageous of writing and ıron best then, they accepted fire as one of the four elements which featured the craft(Mason, 2013, p.13-15). McNeill claimed that, Bronze Age barbarians started to use bronze to

invent new weapons which leaded them overcome their settled neighbors and yoked them easily before mingling in them (McNeill, 1994, p.53-54). A clear phenomenon about the Ancient Turks, they were known as miners in their age that could affect their neighbors in many ways will also discuss later. McNeill pointed out, Minoan Civilization in ancient Crete which shined at these times valued miners and they tried to control pits in Sardinia Island by forming colonies and pursued miners thanks to trading (McNeill, 1994, p.55). Weber stated that, one of the driving forces behind the scientific movement of Middle Age was the idea understanding that ancient times had their own properties and aesthetic view when it was compared to the idea of the seeing the previous history of Catholic World as Age of Barbarians (Weber, 2015, p.213). In the nineteenth century, kind of barbarians, The Zulus, claimed that passing The Red Sea in one night which was written into the Pentateuch and the Bible is not possible and forced the missionary Colenso to write a book about it (Sayili, 1999, p.96). Afterwards, the effect of the legacy of the Enlightenment Age was devolved to nineteenth century, history was considered as a linear process and had purposes which allowed the thinkers to intellectualize it as 'natural sciences' (Özlem, 2012, p.63-64). Hankins indicate that, Enlightenment could not deal with the two paradoxes and the first one is that experimental problems only answered the question of 'what it is' not 'what it should be' thus it did not say anything to people how to they live and if the 'natural causes' or 'reasons' were known, future can be predicted by destroying the idea of 'free man will' and enriched the determinism (Hankins, 2007, p.6-7). By the way, during the these times, China did not accept any kind of holy rule maker who can create the Universal Law (Mason, 2013, p. 67).

The term ‘Law of Nature’ which refers that God control the universe by using some predetermined laws, was firstly developed by Rene Descartes and before him, Ancient Greek choose to use the term ‘principia’ (Mason, 2013, p.154). Besides, those ‘principia’ were eternal and perpetual, Ancient Greek developed three different systems to explained ‘existence’ problem which were known as Elea, Heraclitus and Atomic system and in order of neglecting it, divinizing it, explaining it (Weber, 2015, p.23). Spinoza who were the contemporaneous Descartes explained the ‘Law of Nature’ as being one with divinity and learning these laws is the only way to understand the God and he added that miracles had to be understood by knowing these laws, if it did not they were added some other persons because there was no way to not corresponding the divine power and reason (Adivar, 2012, p.190-191). The ‘existence’ explanation of Heraclitus opposed the idea of ‘certainty’, furthermore, it suggested a ‘Spiritual Law’ (theios nomos) which could be understood by reason, not sense (Weber, 2015, p.32). According to Democritus, there were superior Gods over human however there were superior and certain laws over the Gods (Weber, 2015, p.47). In terms of Science, Natural Laws were considered as stable and orderly repetitive events which could be observed during those repetitions (Yıldırım, 2002, p.98). In the eye of Popper, these laws refer to prohibitions therefore, they did not say that what can be occurred, they define what could not be happened thus they have falsifibiality characteristic (Pooper, 2019, p.93). Hankins thought that causes of the developing the ‘Laws of Nature’ phenomenon had been directly affected by understanding the God’s creation and figuring out the mysterious of this creation which played a crucial role during the Age of Enlightenment and Scientific Revolution and experimental method was formed by approaching the

nature by ‘causal’ attitude (Hankins, 2007, p.2-3). Henry said that experimental method had effects on ‘new philosophy’ rather that Middle Age philosophers (Henry, 1996, p.588). Ozlem said that, ıf the laws of nature concept was evaluated as the fact on Hume or rationalist Kant, Hume claimed that this idea was coming from the kind of false psychic intellectual habits of living of human being which tried to tie up cause and effect relation between cases that means ‘y’ could only be happened and followed by the reason ‘x’ on the contrary Kant opposed this argument and accepted that y could only be happened because of x (Ozlem, 2016, p.91-95). The straight continuity between facts which can be observed by human being created the idea of science (Adivar, 2012, p.9). At the beginning, Copernic Theory combined the earth and space which change the understanding of the order of Earth and passing through the idea of ‘Law of Nature then, Tycho Brahe brought certainty to universe’ knowledge (Koyre, 1989, p.43-44). However, in the modern science especially in the progress of quantum, determinist understandings on earth by using reason approaches started to lose its influence and replaced by uncertainty (Ozlem, 2016, p.98-99).

Swart analyzed the historical background of the ‘Laws of Nature’, he claimed that there are three theory which were called ‘Prescriptive Theory’, ‘Regularization Theory’ and ‘Necessitarianism Theory’ and first and last one have similarities by accepting idea of rule maker God (Swartz, 2003, p.37-38). Mason stated that by referring to Zilsel, ‘Laws of Nature’ perspective had two background and one of them is political variances of European History which was related to creating acts along with the authority of monarchs and ancient religious faiths which were introduced by Judaism first, then accepted by Christianity (Mason, 2013, p.155). According to Ulken, night and day and

seasonal cycles with movement of Sun and Planets based on an order created the idea of ‘order’ which turned to ‘Laws of Nature’ following years (Ulken, 2007, p.11).

Astronomical observations had great progress in ancient times especially by Babylonians in Mesopotamia (Adıvar, 2012, p.22-23) could affect the Jewish-Christianity doctrines. In Kepler’s mind, causality had significant part and he did tried to determine causes rather than saving some thoughts and giving them an order (Koyre, 1989, p.86). According to Westfall, Kepler adapted the Copernican theories to Neoplatonism and made Copernicus’ reform a revolution (Westefall, 2015, p.15-16). Ulken said that astronomy is the character of the laws, and that the concept of law has undergone continuous expansion to the present day (Ulken, 2007, p.13-14). According to Russel, terms of causality was just a habit of the ancient times and then its unnecessity was proved by mathematical astronomy (Yıldırım, 2002, p.123). Calvin and his followers thought that universe was ruled by the laws which were predetermined by God who had absolute power on this mechanism and no more Angels (Mason, 2013, p.163-169). According to Acot who refers to Needham, this is the reason that modern science was established on Western civilization not China (Acot, 2005, p.72).

Spengler suggested that science is a cultural phenomenon and it was not an universal concept (Yıldırım, 2002, p.150). On the cultural perspective, it is impossible to mention to scientific laws according to Feyerabend and he claimed the different cultures were not able to understand other’s science because of lacking the required instruments (Feyerabend, 1995, p.24). Collecting the knowledge was started by whole humanity before the scientific procedures (Aksoy, 1994, p.12) and Ronan suggested that science requires more than gathering the facts, it needed to rationalize this experimental

observations to make generalized theories (Ronan, 2005, p.5). Ozlem argued that, experiments and observations were not only the data collection process, it is the verifying process for hypothesis by facing to some supporting facts about the hypothesis and then, this should be defines as a verification process of hypothesis and experiments create synthetic environment to test the observations (Ozlem, 2016, p.56-57). Ozlem also said that whole facts are not the subject of the science and this represent selective manner of science (Ozlem, 2016, p.56).

According to Yılıdım's comment, science did not contain exacts rules (Yıldırım, 2002, p.110). Before Socrates, the idea of 'Laws of nature' leaned on a pay the price principles in Ancient Greeks (Mason, 2013, p.15). In the nineteenth century, on influence of the laws of nature idea, some advantageous of the nomads were neglected due to linear history idea (Strauss, 2016, p.71). Due to this neglecting, it is possible that no one could define the life of nomadic people as a choice based on their observations and optimal life conditions because of their habitats rather than an inability of farming. As McNeill said, steppe people who ranched and maintained the husbandry knew agricultural life however they considered this as a poor lifestyle and created their own culture (McNeill, 1994, p.37-38). Historiography had been dominated by metaphysic until the Eighteenth century, and then, it was forced to step in the guidance of the natural sciences (Dilthey, 2011, p.21). According to Yıldırım, causality had any relationship with metaphysic, it was just coming out the behavior which always focused on a searching a reason for every circumstances based on an ancient reflection (Yıldırım, 2002, p.124).

The question of the how Ancient Turks survived can be considered as a basic example for this metaphysical idea which suggests that every action will be ended with a

certain result by following a linear path. Radloff, who read the ancient Turkish inscriptions, objected to Chinese texts which defined Turks as miner workers due to their nomadic living (Barthold, 2015, p.26). Sarton said that, nomads needed tools to survive as farmers therefore they invented tools for flaying, carving, etching, smoothing, pulverization processes (Sarton, 1959, p.4). In the introduction of Court's study, which examined pharmacy from ancient times to the 1100s, he tried to understand and use the possible value of plants grown in the nature around them through trial and error studies by experts such as doctors, wise women, physicians and priests in cases where symptoms have not been understood since our most primitive ancestors. even some minerals and animal products are known to be known in public health (Court, 2005, p.21-22). Thompson agrees with this definition of treatments and by saying similar things (Thompson, 1974, p.1). Dogan stated that many developments such as gunpowder, paper, printing press, compass, leverage and vending machine, which were accepted as very important for the scientific and technical world even though the transition to the settled life in China began after Mesopotamia, Egypt and even Central Asia, were developed here (Doğan, 2010, p. 51). Ronan, on the other hand, argues that the immigrations which took during the formation of the Greek civilization, that is, the nomads who invaded there, especially the Dorians, established the 'first geometric' culture (Ronan, 2005, p.66-67). According to Weber, the Dorians opened up an area to spread their thoughts to Pythagoras because they were more backward than the Ionians (Weber, 2015, p.34). The Dorians also brought the iron to the Greek territory with all its political consequences (McNeill, 1994, p.108). Aksoy also emphasized the importance of geography or living conditions in the formation of a scientific society and also stated that in places where

there is political stability, intellectual sciences such as mathematics are expected to have a place for itself (Aksoy, 1994, p.22-24). Another example for geography is the use of clay tablets as a result of an obligation by the Sumerians while papyrus is used in Egypt due to the availability of suitable materials (Doğan, 2010, p.16). According to Doğan, another important example of the effect of geography that in many years the Egyptians was considered as the pioneers of civilization because Sumerians were not able to use papyrus or stone because of lack therefore their legacy mostly destroyed because of natural causes used papyrus and stones because of their geographical possibilities (Dogan, 2010, p.33).

Undoubtedly, although it is not possible to ignore the effect of the living conditions of a society on the cultural life and the world of thought, it should not be preferable to exclude those societies completely with a preliminary acceptance. As Anderson explained, he claimed that the monuments in the East Indies, which were held by the Netherlands until 1930s, was considered that could not be built by indigenous races there, and that they were the product of foreigners (Anderson, 2015, p.201). The Gelons, who knew how to make houses in ancient Greece, were considered to be the people who lived this kind of life because they were Greek (Hartog, 2014, p.103). One way of calling the Persians as ‘barbarian’ in Ancient Greek was to express their inadequacy in terms of weapons, however, when the Persian army confronted the Scythians, they took on a semi-Greek role this time (Hartog, 2014, p.75). However, the Scythians were seen to be less nomadic than any other tribe, they were not always very close to the concept of a nomad who behaved unchanged in everywhere, but it was only a narrative imperative that they were seen as nomads (Hartog, 2014, p.208-211). While

McNeill was stating about these ‘barbarians’, he said that they were the inventors of the new weapons by using new techniques such as improving bronze in the Bronze Age rather than their sedentary neighbors and also used chariot similarly using tanks in modern ages against their enemies and conquered their land and became new political elites who had sovereignty however, they have been defeated by new steppe ‘barbarians’ who invented new weapons based on ıron making technology which was done by using carbon enrichment method during the melting and cooling processes (McNeill, 1994, p.63-70).

People who have stayed out from the Western civilization were educated by their new rulers as the rules wish by using Christianity before science and technology was charged by this task (Feyerabend, 1995, p.8). Adorno and Horkheimer stated that those selected as enemies at the beginning were perceived as enemies and that this is continued with the rationalization trick (Adorno & Horkheimer, 2014, p.247). Directly quoted from Chuangtse by Feyerabend, the fact that Emperor of South Shu and North Hu killed the Emperor of Mid Hun-t’un while they were trying to change him and made similar with them should be considered as a good example of what colonialist did (Feyerabend, 1995, p.152). According to Acot, this situation was supported by the results of Darwin’s Evolution Theory which indicated the ‘sub races’ who were better than monkey but step behind the modern Anglo-Saxon male (Acot, 2005, p.83). This was cooperation between legitimacy of colonialism and the idea of the ‘progress’ which accepted that only one kind of life could possible. The famous historian of science, Sarton, "Jewish and Christian thought affects our world, Indian and Chinese science means nothing in the western world" (Sarton, 1997, p.126), he pointed out the differences in the actual level of

intellectual development. This century had great influence on the contrary perspective of that except Greko-Roman cultures.

When the history of the ancient Turks was considered, the above situation posed a serious problem, as seen in the Radloff example. Particularly in the early studies, the general acceptance that Turks were savages and barbarians was that they had no effect on the civilized life and did not carry the qualifications to be defined as the necessities of civilized life. It was accepted that they are the people who continue their lives by plundering and demolishing for no reason and they are not subject to any order.

The general acceptance that the Turks were barbarians who could not do any scientific-technical activities led to the misunderstanding of this culture and the belief that all the values produced in the field of Inner Asian culture were independent of the Turks. However, with the effect of the role they played in regional politics, the Turks, even though they were not the buyers or users of the products they were not responsible for their production or development, have led the nations responsible for this production to established organized structures as a result of their organization skills.

The dominant view, which ignored the influence of nomads on civilization, caused the Turkish tribes to be completely ignored as a result. The criticism brought by Erdem against a generalization put forward by Paul Lindner about the founding years of the Ottoman Empire is valuable in terms of the nomad-settled issue. Erdem's statements are as follows; ‘At first glance, these assumptions seem to have made a certain appeal based on large generalizations. One of Lindner's most fundamental origins lies in the axiomatic acceptance that nomadic and settled societies, and therefore their livelihoods

and lifestyles, are severely separated from each other. However, both full nomads and settlers had relations at various levels, which would make those societies open to each other's methods and material culture, and some nomadic societies that could be described as semi-nomadic and some nomadic societies were cultivated. Given that nomads throughout Anatolia and Bithynia are not fully nomadic nomads, we can easily assume that they can reduce their commitment to pastures either by obtaining cereals such as barley and oats from their settled neighbors, or by producing them themselves, for example on horses' feeding' (Erdem, 2019). This criticism brought by Erdem can be regarded as a precious criticism against some preconceptions about nomadic life and some theories based on these assumptions. According to Doğan, people who did not have settled life had accumulated serious information by trial and error method, whether the herbs found in nature could be eaten by fruits, whether they can be eaten or not, and their equivalents for animals (Dogan, 2010, p.8). Today, with the help of both archaeological studies and the sources which support these studies, it has been determined that, cities were established in the regions where Turks lived or nomadic tribes became settled when the conditions were provided and they continued their lives as sedentary. Moreover, it is thought that these nomads lived an established life in the periods before they became nomads which will discuss later. It is possible that these peoples had developed a certain level of science-technique as part of their survival, and at least they became the users of these materials through trade. Aksoy's quotation on the development of glass can be an example in this regard. The first glass samples were observed as a result of the reaction of the fire they burned on the shores of the ports where the Phoenician merchants spent

the night with sand until the morning. Although there was a reaction of the silicon in the high fire, there was no scientific or technical purpose and mentality (Aksoy, 1994, p. 40).

Although the issue of science and technique, their definitions of distinction, what is considered science and what is not counted for a long time however general assumptions have been formed today. Boundary problems related to where science started in the 18th century with Hume and Kant in particular, and after Newton's theories emerged, they were considered as a new and scientific theory, and the question was not only to draw a boundary between science and religion but also between science and counter-sciences has become the problem of whether a border can be drawn (Gillies, 2018, p.153-154). Özlem says that the most important criterion that makes a hypothesis a scientific one is that they have to be verified by empirical tools (Özlem, 2016, p.33). Gillies insisted that a complete escape from metaphysics is not possible for science (Gillies, 2018, p.190). Ozlem tried to avoid the 'naïve empirical verification' and he said that postulates are 'universals' in terms of logic therefore it is impossible that testing whole situations for one postulate and then he indicated that, naïve empirical verification must be avoided (Ozlem, 2016, p.34-35). The basic condition for the existence of any science in Popper's words is that the statements are suitable for falsification. Popper, in a footnote which he added to his work, emphasized that the principle of falsification should be seen as a limitation process, not a signification, and said that the procedure should be the one with the most consistency rather than recovering inconsistent results (Popper, 2019, p.64-66). Özlem based this view on what was claimed by Margenau and stated that this is a reverse-based verification process based on facts (Ozlem, 2016, p.3). However, Feyerabend objected this and said that falsification was 'worthless' as a restriction in

terms of its usage in science (Feyerabend, 1995, p.173). Gillies argues that laws which do not have a feature of falsification, such as Newton's first law, should also be included in scientific limitation by proposing certifiable rather than falsification (Gillies, 2018, p.214). Ozlem drew attention to a process called ‘context of invention’ and pointed out that the process which plays a role in ‘context of invention’ is important as to whether the hypotheses put forward are verifiable (Özlem, 2016, p.29).

Although the genesis of science, which is generally understood as such, dates back to the 19th century, its origins go back to the work of Tycho Brahe and Isaac Newton in the 16th century. According to Ulken, Newton realized the idea of complete determinism for the first time in modern science (Ülken, 2007, p.16). By the way, Hilav stated that the idea of determinism have been shaken in modern science (Hilav, 2014, p.236). Ozlem also participated in this idea and stated that the idea of causality based on determinism developed as a result of Newtonian mechanics leaves its place in modern science with the concept of probable causality (Özlem, 2016, p.96-98). Kuhn said that the theory of Einstein, which forms the basis of modern science, is closer to Aristotle than to Newton (Kuhn, 2019, p.316).

In terms of history of science, nineteenth century was the specialization times (Adıvar, 2012b, p.4). Occasionally, this situation has not been taken into consideration in the studies of the History of Science due to anachronistic approaches, and the way the sciences have taken in this last century has been seen as the basis when evaluating the histories. These kinds of evaluations made impossible to write any kind of sciences or, especially history of chemistry, neither Ancient Turks nor all other folks. History of chemistry mostly started with Lavoisier, however before his works people used

knowledge of chemistry to produce pottery, combustion process, paintings, metallurgical applications, producing glass materials and fabricated dyes by using zoological and vegetative process (Dogan, 2010, p.190). Lavoisier was described by his contemporaries as physicists rather than ‘chimiste’ (Hankins, 2007, p.84). Aksoy, while evaluating science in primitive periods, pointed out that today's scientific methods were not known in these times therefore works of these ancient times should not be completely denied because primitive people tried to draw some conclusions by using trial-error method and tried to use them for their own benefit (Aksoy, 1994, p.86-87). Sarton said that, in his study of the medical history of the old periods, the long-term trial and error process of human beings as a result of which the method in which the disease were able to be applied in what disease or what was beneficial and harmful effects, which plant or another object to be used in the treatment of the observations since the primitive ancestors (Sarton, 1959, p.8). Sayili objected the idea which says that the primitive people were far from observation and they were not able to make logical explanations about what they observed, because of the lack of ability to think, and then he claimed that their perception of the world as a result of the way they perceive the hypotheses of the world is hidden in the mask of animism (Sayılı, 1999, p.92). In medicine, according to Sayili, primitive people developed the methods and techniques to heal the illnesses related to their understandings and empirical applications (Sayılı, 1999, p.93). According to Sarton, creating a hole on human skull which was done to reduce pressure for healing was an important improvement (Sarton, 1959, p.9). As can be expected and also explained in more detail below, when the beginning point of sciences has been accepted from the middle of the 19th century, it is unlikely to be mentioned in the History of

Science in any way, not only for pre-Islamic Turks but also for other peoples. In the process of evaluating scientific production in ancient times, it is a problem to approach the rules of modern science by strictly adhering to it. According to Aksoy, Ancient Turks had had to be developed tools or methods which help them to survive however, some problems such as maybe language or writing restricted them to spread this scientific culture in common so, this could avoid it being crucial (Aksoy, 1994, p.97). It is not appropriate to evaluate certain peoples within the framework of certain preliminary assumptions, and as an effort to survive human beings in the past, such as science and technique, to completely resolve and disinterest from areas that have ultimately evolved to solve their problems or have managed to ask new questions. The ancient Turks must have developed methods to survive in nature and to engage in conflicts with other members of the species, as needed by other peoples in the old times.

The sciences are now classified and divided into many sub-branches, that is, the unity of science is now achieved by bringing together the production of many separate sciences in their field of study. Such a separation, classification process is carried out because the inventions are useful although the sciences are closer to each other (Adivar, 2012, p.12). Especially in this age, the intertwining of sciences is quite high and it is often difficult to distinguish where chemistry ends, where physics begins, or to distinguish chemistry and biology from one another in terms of areas of study. Mostly, many disciplines come together and work on a topic as it will be seen below. Sayili stated that there is no classification in the way that people do in nature and that the fields in the classification made during scientific research have been continued to work intertwined but people have to create specialization in terms of ‘understanding and comprehension’

abilities (Sayılı, 2019, p.21). Hankins, in its modern sense, argued that science emerged in the 18th century, stating that the classification among the sciences is only possible with the conditions of today, and that such a situation was not possible for that century and that, for example, practitioners of chemistry are physicians because it was thought that this field was their job (Hankins, 2007, p.10).

Chemistry in the modern sense was formed in the 19th century and its prologue was taken up to the 18th century in the studies that focused on it. Westfall said that the legacy inherited by chemistry in the 17th century was completely different from that of modern chemistry and it was necessary to go to a completely different atmosphere in the way of thinking and using a serious imagination in order to understand it in our age (Westfall, 2015, p.89). Alchemy, which seemed to be its predecessor, was described as a pseudo-science. Although this view is understandable, considering the application areas of chemistry science, it ignores the ongoing cultural activities of human beings. People who made weapons, tried to make medicine and cure, obtained their food, obtained alcohol for religious purposes or for fur, in shortly, they wanted to survive in nature or to make them more comfortable when they have had to deal with chemistry. Sayili pointed out this situation and said that Chemistry was older than Alchemy because alchemy needed chemistry to develop itself (Sayili, 1999, p.91). In the evaluations made on chemistry's history, especially after the scientists who defined this science precisely in the 19th century, there was no consensus on its place, the fact that ancient chemistry remained between mystical witchcraft and craft practices, which were also often required by social life, and this makes difficult to sit on the ground. In the nineteenth century, the age when chemistry has been developed based on synthesis and analysis methods, some

of chemists von Liebig, Hofmann and Willam Perkin developed new methods and techniques to fabricate dyes, however none of them started his career to produce dyes or serve chemistry by producing these kinds of things (Dogan, 2010, p.151). The first person to achieve mechanical energy from heat was Thomas Newcomen, a blacksmith who developed the atmospheric steam engine and one of his predecessors was Otto von Guericke, a German brewer who created mechanical power by providing vacuum through non-mechanical ways (Mason, 2013, p.250). In other words, it was the craft of two craftsmen considering their expertise. Mason stated that these people who developed the ideas as gentleman-amateur scientists, and the first steam engineer who developed his work was a tool maker James Watt at the University of Glasgow, and Professor Joseph Black, a professor of specific heat and phase changes (Mason, 2013, p.251-252). Joseph Black had begun on drugs in his studies (Hankins, 2007, p.89-90). An independent electrical discipline was established with the work of people like Du Fay, Franklin, Cavendish, Coulomb, Galvani, Ampere and Volta after Guericke's works (Doğan, 2010, p.188). In the centuries when the foundations of modern science were laid, development was ensured by the cooperative works of crafts and intellectual sciences. Modern science, on the other hand, had put forward a new and own model of scientist that can be defined as a scientist-philosopher with the studies made to solve the problems encountered in this discipline, especially with the effect of the developments in physics in the 20th century (Özlem, 2016, p.87). The nomadic, semi-nomadic Turks and other Indo-Europeans, the Mongols and their settled neighbors, the Chinese, the Indians and the Iranian tribes in the Central Asian steppes were also dealing with chemistry that could be considered as the subject of chemistry to sustain their lives and produced artifacts that can be viewed as

surplus production. It also exhibited each other through trade and migrations. In the framework of the general difficulty of studying the steppes of Central Asia, the values produced here should be seen as a whole as a cultural area since it would be very difficult to make a nation alone by directly evaluating the written documents. Given the general patterns of scientific endeavor, it is very difficult to directly claim a nation. It cannot be assumed that a people did not have done anything in an area just because of their nomadic culture, but it should be kept in mind that they could lead each other to a number of efforts to ensure the survival of the peoples within the framework of their mutual relations and resulted in the formation of tangible products.

In this context, cultural life of ancient Turks and their political relations must be considered when the area of chemistry was considered with their effects on other tribes also. It would be correct to adopt an approach similar to the concept of Turkish Art to the chemistry produced in the field of Turkish culture in Central Asia. However, before the formation of the concept of modern science, science-art companion can be considered. As expressed by Dilthey, the entire singularization of the human-historical world tries to understand in artistic creation for the first time long before science strives to know it (Dilthey, 2012 p.46). Root of a word 'poet' in Ancient Greek language *poietes* meant to 'constructor' or 'creator' (Eliade, 2000, p.105). The claim that art is destroyed by science by a number of thinkers is far from being realistic and the biggest problem is that these two areas have difficulty understanding each other because of language and expression problems (Yıldırım, 2002, p.154). Nature research has been perceived as an understanding of the art of God until the formation of modern science (Henry, 2011, p.41). Science was also defined by Yıldırım as a 'search process aimed at overall'

(Yıldırım, 2002, p.21). According to Kuhn, the art of painting has been seen as the most important example of accumulation-based progress in human efforts, but especially in the Renaissance years, there was little difference between the sense of art and science, transitions could be made between them and the general definition of technical-craft based on the situation of plastic arts with the abandonment of the 'singularization' process attributed to Dilthey above, the dissociation process began with the natural science of our age (Kuhn, 2019, p.263). Today, however, the dominant view is that art and science are completely separate efforts and cannot be imagined common in any way. However, in a historical study, the spirit and consciousness of the periods, as well as what the concepts meant in the evaluated age should be understood in the best possible way because it is necessary to understand the past ties between science and art.

Feyerabend was one of those who pointed out that art is not science however it included some information and knowledge in its content (Feyerabend, 1995, p.151). However, during the 16th century, during the Renaissance, there was a period in which art developed and science could not place new ideas in its place according to modern rules, and in the following age a great leap of science while art has became dull (Bumin, 2016, p.13). The Renaissance was not a period inspired by science however its target was rhetoric (Koyre, 1989, p.38).

1. SCIENCE, HISTORY OF SCIENCE

In its modern sense, ‘Modern Science is a method of finding and verifying hypotheses that carry the power of explaining the facts through logical observation based on audit observation and verifying them’(Yıldırım, 2002, p.17). According to Sarton, question which focused to understand that science of the ancient times rational or not in the historiography of science had no meaning because it is impossible test the answers and it is clear that primitives needed to survive therefore they developed ideas or tools based on observations or just dealing with the problems had to be considered as a beginning step of scientific endeavours by the way in this process, invention of language and fire were the most important creation of humankind because people could live without writing however they could not without language (Sarton, 1959, p.3-4). Ulken did not extend the search of human knowledge to the time it was in the world and limited it to the last 2500 years, and even considered it only as deviations from the myths and unsciences of the last 300 years because it did not undergo a process of criticism as it was not based on pre-measurement and control (Ülken, 2007, p.1). Modern science is a system and the order that emerged in connection with this phenomenon and the relationship between them to examine and explain (Yildirim, 2002, p.97). Science aims to reveal the general condition of the obligatory relations between the phenomena and to enact laws from these observed phenomenon (Adıvar, 2012, p.10-11). Ozlem emphasized the explanatory aspect of science and stated that it is possible to reach the answer of the causes rather than how it occurs (Özlem, 2016, p.58). According to Aksoy, the definition of science; ‘‘Science is a form of formal information’’ (Aksoy, 1994, p.3). In the introductory part of his study, Özlem described the three most common definitions of

science: ‘‘a-an activity that tries to explain the facts, on one side is an activity (observation, experiment, counting, measurement, etc.) and on the other side is a mental activity (concept, hypothesis, inductive and deductive inference), b- science goes from phenomenon to theory, and c- science develops verifiable theories about facts’’(Özlem, 2016, p.14).

On the other hand, although there are different views on the emergence of science in the modern sense, a range given in the end of the 16th century and the beginning of the 18th century is generally accepted. The importance of science has increased in modern times and it has started to occupy a very large place in the cultural life compared to yesterdays. The discoveries promoted by science have become indispensable for humanity and have become a major part of daily life. According to Feyerabend, the reason why scientific discoveries are seen as important is that people are conditioned in this way (Feyerabend, 1995, p. 103). Another point that was pointed out by Koyre is that the readings made especially considering the place of science in today's culture caused difficulties in understanding the past, however, many great empires, states or civilizations can be established and developed without producing or adding science like its modern sense, even given a place in the Greek civilization does not have a relationship with today's application-based sciences (Koyre, 1989, p.192). Ronan also argued that Greek science made a transition on science which was largely based on practical observation in past civilizations and controlled by elites to intellectual profession and proceed (Ronan, 2005, p.8). Dogan pointed out the mistake of calling Greek science as a miracle and considered it reasons of the beginning of the process of systematic knowledge transfer which was transmitted and maintained through schools, together with a free theoretical

discussion environment that was not experimental (Dogan, 2010, p.14). Weber pointed out that the development of experimental science in the Greeks was extremely slow and added that they believed in the misleading of the senses (Weber, 2015, p.118). The Thales of Miletus who had been accepted by the greatest philosopher and also as the ancestor of the Ion School (Weber, 2015, p.21), used the knowledge of practical geometry which he brought from Egypt and the intellectual aspect of geometry was developed upon this practical accumulation in the Old Greeks and he took nature and experience his basic definitions on earth rather than mystical thoughts (Ronan, 2005, p.72). The Egyptians tried to solve their equations by using a technique called 'wrongly polling' solution (Tekeli, Kahya, Dosay, Demir, Topdemir, Unat & Aydın, 2018, p.6). Known for his contributions to geometry and numerical sciences, Pythagoras, who made arithmetic speculation a part of philosophy, was also born in Samos and traveled to places such as Phenicia, Egypt, Babylon, and received the knowledge of mathematics and geometry of the east along with a number of divinity views (Weber, 2015, p. 33-35). According to Dogan, the contributions of Greek nature philosophers to the geometry they learned from Egypt and Mesopotamia were the process of establishing a proven synthetic geometry based on definition, postulate and axioms (Doğan, 2010, p.20). Before it was developed by Thales, it was observed that his theories were known and applied in Mesopotamia, as seen in the tablets obtained from excavations in Susa (Tekeli et al., 2018, p.12). Hilav argued that it was not possible to distinguish between experimental and intuitive aspects of geometry in his thought, which he based on Gonseth, and stated that it was not possible to think of equal things to understand the word 'equal', for example, and that the symbols used by the mathematician were essentially the result of

repeated experiments in a historical process (Hilav, 2014, p.240). Stuart Mill argued that the axioms used in mathematics and logic was not different from the generalizations of observational natural sciences (Özlem, 2016, p.45). Sayılı also emphasizes the intellectual aspect of mathematics and the effect of this aspect on its non-depression, but it is not correct to think that it is completely disconnected from the practical need to be seen as a mental action disconnected from the outside world (Sayılı, 1999, p.48). Rhind papyrus, one of the most important mathematics books of ancient times, was written in Egypt, however the theoretical aspect of this mathematics was far behind what was predicted and the main demand was arithmetic and geometry for practical applications that could give the most accurate and error-free results in land problems (Dogan, 2010, p.35). From the scientific point of view, technical development has an important place in observation, which was a way of finding facts, the margin of error of the observation process was minimized thanks to the new technical instruments developed, however, the observation of lesser error has been started, in a sense the inadequacy senses has been removed with the help of some technical developments (Yıldırım, 2002, p.79). In Greek science, there was no experimental practice until the Hellenistic period, and no technical progress was introduced to science to make it wider masses and to shed light on today (Doğan, 2010, p.99). According to Weber, one of the main reasons behind the awakening of interest in experimental sciences in terms of medieval philosophy was the rising the interest in Arab (Muslim) schools (Weber, 2015, p.196). Westfall said that studies on experimental research could be taken in Europe before the 17th century, for example, that it could go as far as Galen, but instead of looking at nature as it is, evaluating under a number of experimental conditions was an evolution of this century, and Harvey,

Toricelli even Newton was evaluated by Westfall that their experiments were the applications of the experimental method applied in this way (Westfall, 2015, p.149-150). From the 17th century onwards, nature began to be approached as a mechanical structure, and unlike the Middle Ages, engineer scientists began to follow the path of the engineer, the creator of nature, rather than thinking about God's work and approaching his knowledge (Bumin, 2016, p.24).

The Turkish tribes, which established steppes in Central Asia for a long time and were mostly nomadic and semi-nomadic according to their habitats, and who resided when they had the opportunity, had been forming this background since ancient times either as part of this survival adventure or for religious reasons. Some of the researchers, who see the Turks as a part of nomadic culture, explained the conditions of the region they lived in, especially with their geographical structure and climatic characteristics, and approached the issue as a matter of survival. A part of the researcher insisted that this was a mental issue and continued to see the Turks completely outside the civilization and defined them as predators of settled economies based on agriculture around them, and in a way classified them as 'horde'. It is not possible to evaluate this cultural production of the ancient Turks within the rules of modern science and call it science, and the same applies to their neighbors who are considered civilized. However, ignoring the culture that Turks and their neighbors, who maintained their relations and form a cultural department, for the sake of survival or for religious reasons, caused deficiencies in the construction of a history of science. According to Adıvar, the oldest religious imaginations carried the roots in science (Adıvar, 2012, p.20). In the earliest periods,

humanity was aware of its relationship with itself and its relationship with nature and used this awareness to develop its society and its science (Feyerabend, 1995, p.129).

First of all, what the science is and what the history of science should focus, and then what the chemistry and its history have been, must be understood by the cultural heritage revealed by the ancient Turks in this area should be evaluated to the extent permitted by the resources and archaeological heritage.

1.1. Science

Science is a concept that should not be thought of as ‘always existed’ when it was talked about and it was invented in the modern sense in the modern era during the 19th century (Henry, 2011, p.4-6). However, Hilav spook about science and knowledge, he sayid that it is in fact a deceptive appearance of a detachment from the past, that what is actually based on the past is to overcome it, according to him, the basic character of science is this incompleteness and then could not be ended (Hilav, 2014, p.251). The Turkish Language Institution has three definitions of science; 'Regular knowledge, knowledge that selects a part of the universe or events as subject, tries to draw conclusions by using experimental methods and reality', 'Methodical and stringent knowledge showing general validity and certainty' and 'A specific purpose that starts with the desire to know a certain subject. a process of acquiring knowledge and methodical research' (TDK, 2019). General definition of science is the ‘entire formal information’ (Yıldırım, 2002, p.17). As Aksoy quoted from Russell; ‘‘Science, observation or observation-based reasoning first to find the facts about the world, then the laws that connect these phenomena', according to Einstein quoted ‘‘Science, logical order with all kinds of sensory data (perceptions) and logical order, thought is an effort to ensure

compliance''(Aksoy, 1994, p.9). According to the definition made by Yıldırım, science is a conceptual effort based on observations (Yıldırım, 1999, p.14). According to Ronan, the condition of being able to do science is the use of a vivid and creative imagination supported by strict discipline based on observations (Ronan, 2005, p.5). Aksoy pointed out the generalization stage, which he thought should be seen as a kind of pre-explanation stage of observations of people in nature as a beginning of science and he added that generalizations made in cases where there is not enough information caused misleading information (Aksoy, 1994, p.14-15).Yildirim remarked that science is factual and based on the thesis which came from observation (Yıldırım, 2002, p.29). Scientific thought must be understood by scholars as an intellectual effort and its gaining importance must be well defines (Yıldırım, 2002, p.15). In the Oxford living dictionary, in addition to these matching definitions, there is a definition of 'knowledge of any kind' (Oxford, 2019). Science is defined by Sayili as a 'systematic and correlated body of knowledge, and the scientific study is defined as the process of investigating the relationships between phenomena (Sayılı, 1999, p.9). Systematic functioning, focusing on specific issues and trying to explain it through experimentation or observation is the point where all definitions agree. According to a definition made by Dilthey; science should be understood as a set of principles in which concepts are formed from themselves (Dilthey, 2012, p.22). Leonardo Da Vinci, in his book '*Trattato della pitturada*', said that any other human researches which are not suitable for mathematical representation cannot be described as real science (Wootton, 2019, p.37). As reported by Koyre from Duhem, Da Vinci was the most important representative of the scientific continuity and unity between the Middle-Age and the New Age (Koyre, 1989, p.93).

Unlike Newton, Da Vinci was an engineer who decided what he wanted to achieve and developed the tools to lead him to this conclusion (Koyre, 1989, p.98), therefore he stick to methods of mathematics. Mathematics has a high level of certainty even in the most advanced empirical sciences in terms of the their results could reach, especially in the geometry of the Euclidean system until the emergence of new systems have been perceived as invariant facts, starting from the 19th century, the logic has been found to be consistent with other axioms (Yıldırım, 2002, p.39). This knowledge of the geometry used for the development of Newtonian mechanics had been developed in 300 BC and was thought to explain space geometry for nearly 2000 years and it was thought that the downfall of Euclidean geometry was the most important event in the history of science for any kind of epistemologist according to Gilles quotation from Putnam (Gillies, 2018, p.76). In the Riemann and Lobachevsky geometries, when the interior angles of a triangle are summed, there is no result equal to the sum of the two right angles, this is no more than the axioms accepted by Euclidean geometry, and in this respect the deduction is precisely due to the fact that the accuracy or falsity of the axiom does not rely on a preliminary assumption (Özlem, 2016, p.48-50). In Riemann geometry, the sum of the interior angles of the triangle is greater than 180, whereas Bolyai-Lobachevsky geometry is less than 180 (Gillies, 2018, pp. 80-81). Mathematics is a deductive system that continues with axioms, the predecessors of axioms theory creates the results derived from these a priori concepts (Yıldırım, 2002, p.42). Hilav, in his evaluation of axioms, said that they have been derived from facts and were related to experience (Hilav, 2014, p.244). Especially in the Middle Ages, the dominant geometry and its views behind this deductive structure together with the Renaissance and Aristotle's views began to be

preferred to the views of Plato and his experiment and observation as Socrates' unnecessary 'Theory of Ideas' developed by finding unnecessary role had an inductive method has acquired a place for itself (Ronan, 2005, p.99). According to Nutton, the medical-based experimental method and Paracelsian views throughout the 17th century, despite the existence of the majority of the theory-based tradition remains connected (Nutton, 1997, p.27). However, the Jesuits, who were known for their contributions to education, had adopted Aristotelianism as their official philosophy and represented and in the Molland's mind they were the most scientifically advanced people of their time (Molland, 1996, p.565). Aristotelian system was the consensus of the information obtained as a result of the inferences made from the causes and it was important to start from an unproven first cause, and has made a science classification based on the events that emerge from the induction (Hilav, 2014, p.47). According to Ulken, Aristotle's science was far from the idea of the laws of nature and connected to same logic which physics and metaphysics have shown because of lack of linking (Ülken, 2007, p.56). In Plato's philosophy, geometry has served most, and his philosophy, like geometry, was based on *a priori* intuitions, and its precepts were based on the rules of mathematics (Weber, 2015, p.63). Rationalism and empiricism, two methods which were used as the answers in the epistemology, the oldest and classical version of the first one could find in Plato and his theory of Forms based on memorization by accepting reason the only source of the science then it has been continued until the modern times and senses have been ignored (Ozlem, 2014, p.39-41). Ronan revived in his work about the thought technique, which was invaluable for mathematics, which was based on putting forward arguments at an abstract and theoretical level to respond to needs rather than a direct

observation of nature, was damaged by Socrates and Plato (Ronan, 2005, p.91). In Plato, the function of science was to pull out the objects and memories that the spirit had seen and recognized directly before coming into the world, and science was tasked with searching for certain results called ‘form’ (Hilav, 2014, p.43). The greatest contribution of mathematics to science is primarily the language function it demonstrates in the clear expression of scientific findings and the testing of these findings, which required the existence of a language specific to science in the absence of everyday language (Yıldırım, 2002, p.43-46). Ozlem stated that science needs an ‘artificial’ language in the face of the uncertainty and multi-meaning problem of the daily language which is related to the culture called historical language (Özlem, 2016, p.19). Continuum and infinity terms which were developed by Aristo influenced and led Newton and Leibniz to calculate infinitesimal calculus (Ronan, 2005, p.107).

In terms of the definition of science, due to its non-stationary and constantly changing structure, along with the difficulty of drawing the subject and its borders, which caused difficulties due to gray regions (Yıldırım, 2002, p.16). One of those who stated that science can never remain constant as a concept and has been always constantly changing has been Aksoy (Aksoy, 1994, p.6). Feyerabend also noted the difficulty in defining the boundaries of science, after emphasizing the necessity of separating science and non-science, he pointed out that these definitions of ‘science’ and ‘non science’ are permeable to limiting and that the boundary is faded (Feyerabend, 1995, p.27). In his attempt to draw the boundary about what is science and what is not, Yıldırım's suggestion is that in the narrowest sense, non-factual problems cannot be accepted as science which cannot be solved by experiments, but he added that discussions have still been continuing

on this subject (Yıldırım, 2002, p. 59). In terms of scientific method, Yıldırım has classified logical ways of inference such as induction, deduction, hypothetical deduction, retroduction and problem solving (Yıldırım, 2002, p.67). According to Özlem, retroduction can be defined as; 'objects and processes that are left out of observation are a form of inference that expects to be explained by our designs obtained by assumption and brings together our observations' and Newton has brought together a phenomenon that is outside of this observation, gravity, as a result of an observation he made while explaining gravity (Özlem, 2016, p.52). Most of the scientific laws have been formed by bounding this thought according to Ozlem and he also said that it did not define how laws formed they just tried to reach general explanation for some inconvenient experimental results (Ozlem, 2016, p.61-62).

Sarton's short description is; ‘Science is systematized positive information’ (Sarton, 1999, p.19). From the Fara’s point of view, it is unnecessary effort to define what science is or how it can be defines since according to Fara, there is much interesting questions and problems about science thus focusing on the cultural root of the science is more important (Fara, 2015, p.15). Aksoy shared a similar view and stated that it is difficult to define science and that its perception in every age has changed (Aksoy, 1994, p.8). According to Fara's opinion, it is difficult to establish science and it would never be right to define science as ‘the work of the scientist’, since the word ‘scientist was invented in 1833 and used first time (Fara, 2015, p.14). Even the great scientists of their century, such as Kelvin, Faraday and Darwin, chose to stay away from this concept (Fara, 2015, p.260). However, the terms 'scienziati', 'French savants', 'German Naturforscher' and 'English virtuosi' were used to describe the people involved in 'natural

sciences' (Wootton, 2019, p.41). According to Ronan, those who were raised by the ancient Greek civilization and who were among the pioneers of modern science would choose the philosopher of nature, which was used for them in the 17th century, and would not see the term scientist as appropriate, and although their field of activity was not a science according to their age, it was certainly not like today's science (Ronan, 2005, p.136). According to Medawar quoted from Coleridge' work, the first scientists were people who approached the object with pure curiosity and desired to know instead of thinking about their needs (Medawar, 2002, p.233). According to Dogan, in ancient times, people did not aim at science and research, but they tried to meet their needs more easily and survived while satisfying their feelings of curiosity while observing the nature around them and using it as a source for their future knowledge (Doğan, 2010, p.4). Then, Ronan emphasized that science is not limited to everyday needs since also a result of curiosity (Ronan, 2005, p.9). This definition seems to be positive in terms of evaluating the applications in the approach to science by considering the thoughts of its own age. According to Aksoy, the first scientists were those who made and classified this cumulative process in the process of accumulating information that began long before science (Aksoy, 1994, p.13). According to Ozlem, after stating that science was carried out thanks to the desire of 'utilitarian knowing' and 'purely knowing', the result of 'utilitarian knowing' is that the studies made on behalf of science could be used by people through technical applications that can benefit the society, since the principle that activates the real scientist was basically 'pure knowing' which indicates that there is an effort to observe and understand the universe which is based on the will and keeps society in the frame (Özlem, 2016, p.13). Popper explained the duty of the scientist as a

propounding the system of scientific propositions and thesis then testing what they suggest systematically in the light of experience based on experiment and observation (Popper, 2019, p.51).

The word ‘science’ comes from *scientia*, which means ‘knowledge’ in Latin for western languages (Wootton, 2019, p.36). *Scientia*, continuous and repetitive events, that was the activity that aims to determine the legalization of the relationship between the facts in this continuous structure (Özlem, 2010, p.59). According to Fara, although the definition of this word is extremely difficult and problematic, it has absolutely nothing to do with today's meaning and shares the same fate with the Greek word *techne*, which means 'knowledge from practical studies', and this word is related to handicrafts, rather than closing to craft in modern times (Fara, 2015, p.63). The divergence between the artisans and the written disciplines held by the clergy began to be seen in ancient Mesopotamian and Egyptian civilizations. Education of clergy lasted almost twelve years in Ancient Egyp and it was the most valuable profession they also lived in Imperial Palace under the special service of pharoahs (Tez, 2016, p.10). While medicine, which was recorded for both calendars and astrological signs such as mathematics and astronomy, developed their own written documents in the hands of the clergy, there were no records in the chemical practices which were the craftsmen's field and these were narrated orally (Mason, 2013, p.11). In the early times of Chinese medicine, the priest aspect of physicians was also in the forefront due to the tribal presidencies, and clergy and witchcraft were left to these priest-physicians, who both managed religious and sacrifice ceremonies and tried to treat patients by enchantment or medicine (Doğan, 2010, p.59). In China, which has developed in crafts, the science has been designed to be

useful, and in the meantime, they have not developed an atomic theory, but they have achieved many important developments in black gunpowder, compass, paper, printing and iron workmanship (Doğan, 2010, p.54). Ronan pointed out that the crafts were very developed in Ancient Egypt and it was stated that they had a very practical knowledge in metallurgy, mine and geology in connection with them, especially as a result of practical applications (Ronan, 2005, p.27).

Drawing attention to the connection of magic with technological progress in ancient times, Dogan emphasized that these magicians continue their lives with the information they have developed and do not share with people, and that the things done as a result of the mystery of unknownness appear to other people as magical or mysterious knowledge. He points out that bronze or metal age wizards are chemists who decompose metal in the soil or produce essences from plants and fruits, and often point out that newly developed magical methods should be perceived as a technological development (Doğan, 2010, p.8). Henry described the definition of magic as the establishment of control over nature through a practical endeavor that is the field of his technique and craft (Henry, 1996, p.583). According to Adıvar, the first science was established on magic and craft, which can be called, technique (Adıvar, 2012, p.9). When Henry discussed the role of magic in modern science, he argued that magic should not be seen in one piece, and that there is no contribution from magic those who call it Natural Magic (Henry, 1996, p.586).

Dogan opposed to the fact that in the studies of the history of science, the general acceptance was that technical development had started as a result of the development of a scientific thought that started with philosophy. In fact, people knowingly developed

technology, although it is unaware of the laws when it is necessary to build shakes and boats, or emphasizes that the methods to store food to feed themselves (Doğan, 2010, p.6). Sayili says that in the past, especially in the Ancient Greeks, there was no association between scientific development and technological development, as opposed to the closeness of science and technology in our age, and that technical progress was more intense in the late Hellenistic, Roman and Middle Ages, which were regarded as static years in terms of intellectual science (Sayılı, 1999, p.82). Mesopotamian medicine is also a kind of scientific methods based on herbs, animals, screeds, which in ancient times in China with starch was used to make paints (Dogan, 2010, p.58) as well as the use of minerals such as ground stone and salt as a drug It was based on magic and prophecy (Ronan, 2005, p.35). These civilizations knew bandages, plaster, wounds cleaning and herbal remedies, and they also made precise weighing and measurements, especially in the Babylonian period. They also developed soap, vinegar, beer, wine, glass making technologies, and obtained natural aromas from plants and animals, since as they were evaluated by Court, they were not real chemists and technology producer they succeeded in trial and error (Court, 2005, p.22). With respect to tablets from Asurbanibal library and Nebule tablets it could be understood that the sorcerers and physicians were involved in the treatment, in addition, the Babylonians had herbal prescriptions, according to tablets dated to the 7th century BC, up to 250 plants could use as a drug (Doğan, 2010, p.22-23). Up to 120 minerals that are still in use even today have been identified (Court, 2005, p.23). In China, physicians believed that some illnesses came from evil spirits, and instead of applying the commonly used drug treatment, they used magic (Doğan, 2010, p.60). Chinese medicine was under the influence of the Ying-Yang

principle based on the fact that the universe is in a continuous movement and continuous formation (Tekeli et al., 2018, p.3). In ancient Greeks, there was a similar magic-based process in the process of using plants as medicine and also there were beliefs that the plant would be collected with magical words during this process (Ronan, 2005, p.94). Shen Nung, thought to have written his work in the first century BC, was considered to be the founder of Chinese Medicine who spoke of 240 herbal and 125 animal drugs (Doğan, 2010, p.59). Dogan, who made a general evaluation by using Eber, Edwin Smith, Ramasseum, Kahun, London, Hearts Papyrus about the medical applications in Ancient Egypt, although some of the medical recommendations based on magic and magic prominent, it was more appropriate for today's medical understanding of surgery and medicine info were also given. While magic and magic practices came to the fore in the early periods, it was pointed out that modern methods began to manifest themselves depending on the observations and that there was some information that hopeless cases could be treated with magic in this era (Doğan, 2010, p.40). The Eber papyrus has been described by Thompson as a health encyclopedia (Thompson, 1974, p.4).

Bodenheimer drew attention to the relationship between clergy and science, in other words, religion and science in these lines; ‘‘Science seems to be the main means of achieving this common purpose, the glorification of God through knowledge’’ (Acot, 2005, p.63). Science, especially from the 16th century a sense of unity of existence was involved (Adivar, 2012, p.142). For Bacon and Descartes, science also means serving God, and in 1628 the Cardinal encouraged Descartes to publicize his views immediately to the wider masses because of the benefit of religion (Bumin, 2016, p.35). The main difference between these two is the idea of Descartes' based on mathematics, geometry

and algebra, unlike Bacon's based on experiment (Adivar, 2012, p.174). Westfall stated that the Descartes School of Mechanical Philosophy was in conflict with the Pythagorean mathematical tradition due to the importance it attached to physical experimentation, and that the science he has developed was based on a new causality, a new interpretation of known events, not on the discovery of new phenomena based on meticulous observation and research on nature (Westfall, 2015, p.55-57). After Weber disagreed with this approach, like Westfall, who clearly claimed that this idea of contrast was came from ignorance, added that Descartes was not a philosopher who used mathematics, he was a metaphysical mathematician, and he added that he was not only an internal observer; ‘‘The idea of decartism was the application of geometric method to metaphysics to make a definite science’’ (Weber, 2015, p.230-231). Bacon based the idea of progress on the craft and said that it would develop continuously and in science, a closed and final philosophy of nature could be established with the belief that the discovery of arts could develop continuously. While Bacon defended the craft based on accumulation, Descartes explained his scientific method as a final result, the result that mechanical laws would lead us to (Mason, 2013, p.286-288). Like Bacon, Descartes was not the founder of experimentalism, but he also did not completely reject the experiment and argued that it was valid in scientific details (Westfall, 2015, p.148). In his study, Briskman examined rationalism, after putting Descartes on the side of intellectualism and Bacon on the side of empiricism then, in fact, the two views were very deeply connected to each other according to their primarily optimistic commitments about achieving rational knowledge and they both believed that it is a crime and not to obtain the traditional methods should be aside from the beginning with the radicalist structures, and finally not getting the

knowledge was the guilt of humanity after saying that these two views were constructed as a basis of the Modern Science that emerged with the Enlightenment, by the way both were show that they were wrong by pointing that Newton cannot be found right with pure reason, while he insisted that this was the result of experience and induction, he prevented the destruction of Bacon's view, but Hume and Bacon's empiricism was overcome by showing that he could not make the necessary justification for the existence of universal laws (Briskman, 1996, p.168-170). Roger Bacon, under the influence of his teacher Robert Grosseteste in the 13th century, said that reliable information could be reached as a result of the coexistence of reason and experiment, and that the proving experiment followed to be a data collector and even the truth controller before (Tekeli et al., 2018, p.108). For the ancient Greek civilization, Mason quoted Xenophon as saying; ‘‘Mechanical arts carry a negative social stamp in society and are rightly seen as a shame in our cities’’ (Mason, 2013, p.23). In Ancient Greek, hand labour (*banausia* in Greek) identified with slavery work while entelecutal work identifed with masters (Tez, 2016, p.8). The punishment of Prometheus, the representative of the technique which stole fire from the gods for the ancient Greeks, showed the fear of the technique (Bumin, 2016, p.23). However, it is also not possible to talk about a technical-science convergence as today in the old times in the Islamic world, which did not have the habit of leaving handcrafts to slaves (Sayılı, 1999, p.109). In Greek civilization where slave labor was strong, the surplus of workers prevented people from benefiting from the machines which are the product of the technique, and the social belief that the activities requiring physical power belong to the slaves also underestimated the arm force and humiliated both the craftsman and his all technical activities (Bumin , 2016, p.28). On the contrary, Romans

clearly stated that the waterways they built in the city were superior to the ‘dysfunctional pyramids’ in Egypt and the ‘famous and useless’ intellectual knowledge of the Greeks (Sayılı, 1999, p.101-102). Archimedes was also subjected to such criticism because of the method of working by arm-power (Adivar, 2012, p.63). According to Plato, the internal flow of nature was not important and had to be taken into account in the degree to which it influenced intellectual purposes, he was looking at the universe in mathematics (Mason, 2013, p.24-25). In his ideal state, handcrafted works were left to slaves, and philosophers and educators were despised to deal with these works, and this situation has advanced enough to cause the transition of the profession of surgery from physicians to barbers in Medieval Europe (Sayılı, 1999, p.109). Plato even resented the use of mechanical tools in the solution of geometry problems on the grounds that he reduced non-material intellectual subjects to material level (Bumin, 2016, p.28).

Ronan posed a question of whether Plato's impact on science was positive or negative, and he found it very valuable in mathematics, but said that his approach to experimentation and practice was particularly detrimental because he considered it a low level of endeavor. In fact, Greek Science which was always based on speculative and intellectual study was pushed by his own Theory of Ideas to little more speculative side (Ronan, 2005, p.102).

According to Plato, good physics is not *a priori* in nature, there is *a priori* in itself, and then the theory comes before the facts and the experiment is not necessary, the information sought before the experiment is already known, the important thing is the perception and expression of mathematical laws (Koyre, 1989, p.155). Plato united his realm of ideals with the material realm so called *mathema* which is the middle realm

(Adıvar, 2012, p.41). In a footnote in Weber's work, *mathcmata* was defined as the general name of the Pythagorean sciences but also the root of the word *mathematics* (Weber, 2015, p.34). In the Medieval Age, those who saw mathematics as an ancillary instrument dealing with abstractions and not pursuing real questions, and those who argued that physics should be perceived by the senses were seen in the side of Aristotle, and those who believed that mathematics was the key were those who followed Plato (Koyre, 1989, p.156). Hilav, on the other hand, has different ideas about mathematics, and argued that the premise that mathematics was an out-of-time effort with invariant truths is a false idea of old times, and argues that the underlying ideas of mathematics are essentially the result of an interaction of human mind and experience, which is not so different from physical sciences. He then completed his thought with a reference to Gonseth; ‘‘Mathematics is not a monument firmly rested on any foundation, it is a disgraceful structure that can be considered as a miracle, and not destruction is the most amazing and incredible adventure of the human mind’’ (Hilav, 2014, p.237).

Along with the Enlightenment period, the concept of ‘argument’ began to change in scientific thought, and this change began to make life more equipped and easier to live (Adorno & Horkheimer, 2014, p.21). With the new age, a period began between the thinkers who accepted empiricism and rationalism, when both theories understood the importance of each other (Özlem, 2016, p.42-43). Essentially, it is an ongoing opinion that scientists who use practical and experimental knowledge and who do not study in the intellectual part of science are not more than ordinary people who can be seen as slaves or technical experts who did the rough works of ancient times and then intellectual values of these scientists should not be seen (Yıldırım, 2002, p.149).

The belief which defined experience was more reliable than authority, and then the value of craftsmen's ideas and practices in understanding the practical world has been strengthened over the 16th century (Henry, 2011, p.39). William Gilbert explicitly argued that craft and scientific knowledge should be brought together, not only devoting his work to the ‘either that people who did not seek the knowledge from the book or else that seeking from objects’ and rejected the traditional conception of science after blindly blaming belief in authority (Mason, 2013, p.124). However, the views put forward by Gilbert were inconsistent with Galileo's experimental approach, even so Gilbert's book was considered one of the first examples of experimental science activity because he tested the magnetizing power of diamonds by spending 75 diamonds (Westfall, 2015, p.42-43). Separating science from non-science was not easy, as the philosophers of science have stated (Henry, 2011, p.47). Bacon also despised the followers of tradition and he formulated them like; ‘‘people who thought that someone know what they do not know then they know what someone does not know’’ (Adorno & Horkheimer, 2014, p.19). Bacon clearly stand on the side of Democritus, who emphasized the importance of experience and practice while establishing the philosophy of Greek thinkers and stated that he would prefer Aristotle over him (Adıvar, 2012, p.37). For Westfall’ opinion, the main founder of the experimental view was the chemist Robert Boyle, and Boyle proposed experiments that were planned to achieve or not to come to an end, rather than rambling observation (Westfall, 2015, d.149). Boyle, however, argued that the concept of ultimate causality was the wisdom of God and that it could never be known, but argued that know-how could also be used as evidence for the existence of God (Moran, 2005, p.138). Henry said that Boyle's inductive logic was essentially influenced by methods of

natural magic through the collection of phenomena related to nature by empirical studies independent of theory, and says that his understanding of nature belongs to sorcerers rather than academics for his own age (Henry 1996). 590-591). A century before Gilbert's lines, Nicolo Tartaglia, who lived in the first half of the 16th century, said that the distinction between theory and practice should be extinguished (Henry, 2011, p.23). In Tartaglia's view, mathematics and geometry should focus on things which constructed temporal, and one of his contemporary Simon Stevin who was also the founder of hydrostatic science, remarked the impact of experiments on crafts and emphasized the importance of (multidisciplinary) collaboration in scientific projects (Mason, 2013, p.134-). 136). Vanoccio Biringuccio, a mining engineer who wrote a book called '*De la Pirotechnica*' in 1540, wrote it for artisans, and at the same time, Georgius Agricola (also known as Georg Bauer from Bohemian mining industry) who invented a pumping system 93 horsepower (Mason, 2013, p.248), published his book '*De Re Metallica*', which included his lifelong observations, experiences and learning (Greenberg, 2003, p.55). Last one had written for well-educated classes in Latin, covering the same subjects as Biringuccio's book, but in contrast to the predecessor of the former being Italian (Henry, 2011, p.33). Biringuccio, who both benefited and praised alchemy and also Da Vinci who criticized the Alchemists since used another very old Alchemy method to separate gold and silver in gold coloring, and on the one hand he said that Alchemy was a dream. When they wanted to dealing with metals and the changes to be made in them, Alchemy's technical practices were involved and actually their concerns were about what the Alchemists wanted to achieve, not what they did (Moran, 2005, p.38-40). In this age, German palaces wanted the mines to become more profitable (Fara, 2015, p.148). In the

Mediaeval Age, alchemy was an area outside the university, independent of the authority that could not find a place in the dogmatic education programs of universities (Fara, 2015, p.127). Alchemy was also cursed by the church as a devil's work and considered 'Black Art' (Tez, 2010, p.9). Westfall, who sees the Science Revolution as a radical arrangement for understanding the functioning of nature in the 16th and 17th centuries, accepted the interaction between science and technique in a number of fields, but does not participate in this approach from an industrial perspective (Westfall, 1997, p.72). However, in the mining industry, studies on the way from heat to mechanical power led to observations by water engineers that water could not be lifted by more than 30 meters by suction pumps, which resulted in Galileo claiming that this would not be a limit and could apply to other liquids (Mason, 2013, p. 249). Experiment and observation began to become a basic process in the collection of cases and observation, in particular, a 'fact finding' process, that is, the researcher has begun to become the process to selectively examine within the scope of his own subject (Yıldırım, 2002, p.77). In these years, Paracelsus, who will be accepted as the founder of chemical medicine after a while, brought together academics and craftsmen in his own lessons and also opposed authority by burning the books of Galen and Avicenna before his classes, has been working in the metallurgy atelier of German mines of Sigismund Fugger (Mason, 2013, p.206). Adıvar also claimed that the beginning of modern science can be searched in Paracelsus (Adıvar, 2012, p.143). Westfall also stated that Paracelsus's work gave chemistry most advanced form, but it should not be overlooked by his religious motivation in this field (Westfall, 2015, p.91). Medical elites opposed Paracelsus's suggestion for the treatment of syphilitic mercury, as the medical elites of the time, especially those of imported herbal medicines,

would harm their profits, which, as Jaffe pointed out he had poor relations with the dominant medical elite of his time (Jaffe, 1976, p.14) and even Paracelsus was the founder of toxicology, like Westfall, Alptekin pointed out that some of his views seem irrational as a result of his proximity to hermetism (Alptekin, 2019, p.135-136).

Although the rapprochement between science and technique was felt in the 16th century, it would have to wait until the end of the 19th century to see its real effects, as Fara explained (Acot, 2005, p.103). Even Gilbert, despite all his critical attitudes, had a magic-based thought (Henry, 2011, p.57). Gilbert did not have a scientific mentality in its modern sense. His pioneering book, De Magnete, was full of examples of 'animistic' and 'magic' approaches, and he saw the movement of the world as a supernatural spell object, looking for a soul in magnetism and trying to explain the world in this system (Henry, 2011, p.57). According to Westfall, this work could be seen as a very strange book for the heads of the modern era shaped by modern science, but it was a complete expression of the understanding based on the supernatural and psychic forces developed by the Renaissance-shaped naturalism of its time (Westfall, 2015, p.46). Magic was called pre-science for scholars and it also represents the first causality concept in human mind which connects the causes and reasons each other (Adıvar, 2012, p.21). In the Mediaeval Age, especially from the mixture of new ideas and a number of superstitions, the so-called Theosophical by Weber, which will eventually turn into magic, has strengthened the belief in the supernatural as well (Weber, 2015, p.201). As expressed by Fara; ''at the heart of modern scientific knowledge lies magic ideas, like modern science, magic required the combination of intellectual and manual skills'' (Fara, 2015, p.144-148). Ronan underlines that it is not possible to talk about the history of science without

being confronted with magic, which is essentially a synthesis of nature and its relationship to mankind (Ronan, 2005, p.6). According to Adıvar, the understanding of science that was dominant at the end of the middle times and the beginning of the Renaissance was mixed with magic and it was very difficult to distinguish, Faust devoted himself to magic (Adıvar, 2012, p.142). The Renaissance was not a period when the printing houses printed the translations most of times, but it was a period in which Koyre's words, gin-pixy' science and magic books were published, and they did not know that magic was ridiculous (Koyre, 1989, p.39-40).By the way publishing was not a work for sacrifice, it was a job for the purpose of earning money, and the translation of a number of financial necessities had to be overcome, and this difficulty was encountered in the publication of Galen's works (Nutton, 1997, p.22-23). Adıvar stated that the trio of science-magic – religion, especially at the beginning, is difficult to distinguish between them (Adıvar, 2012, p.10). According to Ronan, the spell-based vision was originally quite suitable for establishing relationships between natural phenomena (Ronan, 2005, p.7). Fara states that especially the experts of modern science find it difficult to accept that the history of their fields is based on these roots, especially historical practices such as magic or astrology, and that the advocates of the scientific logic eliminate them, and that the views of progressists do not conform to historical facts (Fara, 2015, p.21). Henry describes the anger toward Helmontism as *whiggish* because of his magical-religious approach and emphasized that this trend is very important for understanding the world in an experimental way, Joan Baptista von Helmont was also one of the thinkers who influenced Robert Boyle (Henry, 2011, p.43). With his belief in the invisible forces behind the material world, Helmont is not very different from Gilbert, the founder of

Magnetism, but he has doubted the fear of 'magic' and has replaced the idea of 'causes' with the idea of the effect of not knowing the real causes yet (Westfall, 2015, p. 47). By the way, Helmont said that time could be determined by using a pendulum, he carried out some chemical studies on the thermometer, developed a sensitive balance, and also succeeded in detecting the carbon dioxide he called ‘Sylvester Gas’ (Alptekin, 2019, p.137). Ronan acknowledges that the scientific view, which gains importance instead of magic, is not more rational, but a different perspective, but that it also provides people with more functional tools to understand nature, shape it, and make more accurate predictions for its future (Ronan, 2005, p.8). Helomont, in the 17th century, stated that chemistry education as a chemist-physician should be included in the curriculum of universities and that the experimenter part requiring manual dexterity should be used (Mason, 2013, p.212). Before Helmont developed these theories, the use of cassava in Central America was cultivated for subsoil tubers used for flour, bread, tapioca, starch, and alcoholic beverage production, and the these tubers were purified from some form of cyanide poison after a number of operations, on the one hand, although it was the subject of chemistry and pharmacy in modern science, it was an important example of observation, research logic and rational approach at that time (Ronan, 2005, p.10). Sarton also mentioned the importance of this technique developed by the peoples of Old America and added that the deadly effect of food containing hydrocyanic acid was eliminated as a result of special cooking process (Sarton, 1959, p.5). Unlike the contemporaries living in other parts of the world, these ancient peoples who learned to separate the poisons did not use metals other than ornaments, developed the technique of wall construction without plasters and made studies on irrigation systems, however they

could not find the wheel (Doğan, 2010, p.74-78). The understanding of magic in ancient times was different from the present, and what they perceived as supernatural depends on the functioning of natural processes and was experimenter (Henry, 2011, p.52). Ronan stated that the effort of the oldest civilizations to observe the natural phenomena and make a connection with their own cosmological universe was remarkable, adding that mathematics came to the forefront beyond the practical necessity from time to time and claimed that some kind of magic belief focused on the relations between the facts (Ronan, 2005, p. 62-63). Newton, who was seen as the founder of modern science, was in fact an alchemist, in other words he was engaged in 'false science' which was the magic. Although Yıldırım claimed that the conflict between science and religion was historical (Yıldırım, 2002, p.26), Robert Boyle, who gave lectures to fight atheism before he died and to explained that there was no faithlessness in the new philosophy, was a alchemist like Newton (Henry, 2011, p. 88). Moran referred to Lawrance Principe and stated that Boyle itself represents the continuity established between Chemistry and Alchemy during the Science Revolution (Moran, 2005, p.145). Pythagoras, who lived centuries ago before Boyle and was regarded as the first scientist for some, was a religious leader, founder of a special sect, who participated in the religious revival movements in the Greek world in the 6th century BC (Ronan, 2005, p.75). Boyle opposed the scholastic thought known as 'four elements theory' in chemistry (Adivar, 2012, p.192). Robert Boyle, as a mechanic philosopher, however, argued that chemistry should be based on experimental observation, and although he could not systematize chemistry with his own theory by advocating quantitative observations of changes, chemical reactions, his pure substance approach also contributed to the establishment of modern recipe of chemistry (Mason,

2013, pp.215-216). According to Hunter, the work of alchemy and transmutation was limited by Robert Boyle because of his morality and religious views, on the contrary to Newton (Hunter, 1997, p.157). Robert Boyle was the proponent of a law that is still in use today with a gas law honoring by his name, that the volume and pressure of a certain amount of gas is constant (Doğan, 2010, p.146). According to Hankins, his contribution to the combustion problem has been shown by his vacuum pump experiments, which show that both combustion and animal death occur when the air moves away from the tube, and that respiration, combustion and calcination in this direction are due to a characteristic of air or just air (Hankins, 2007, p.93). Combustion problem played the key role in Revolution of Chemistry as it will be seen below. However, Boyle did not engage in a conflict with religion and claimed that God could intervene at any time during the formation and continuation of existence in his philosophy, which he expresses in a religious way developed by himself, and that the human soul is a reflection of God (Adıvar, 2012, p.192).

Wootton, who defended the beginning of the 'Science Revolution' with Brahe's work in 1572, defined the production as the information systems before and argued that astronomy was only the productions that resembled modern science, and said that this structure enabled it to become the first real science discipline (Wootton, 2019, p. .17). Hankins uses the term Science Revolution in the first part of his book in which he analyzes the character of the Enlightenment period and says that cultural activity was completed in the 18th century by attributing it to nature philosophers such as Galileo, Kepler, Descartes and Newton (Hankins, 2007, p.1). Schuster chose to extend the range of the Science Revolution a little wider, saw it as a period between 1500 and 1700, and

said that the Medieval Age worldview was destroyed in institutional and mental terms, and even Schuster evaluated this period in three separate stages (Schuster, 1996, p. 217-238). According to Field and James, they stated that the terms Science Revolution and Renaissance defined real phenomena, but they were used for short, indefinite and non-measurable processes (Field & James, 1997, p.1). Tamny considered the Science Revolution as the partner of the new Mechanical Philosophy, which began to emerge in the 16th and 17th centuries (Tamny, 1996, p.597). Koyre was one of those who saw the beginning of a 16th century scientific revolution as the beginning of the transition from the effort to watch nature to the domination of it. In this age, both the Cosmos collapsed and the concepts connected to it cleared the thoughts, as well as the geometry of space and science mathematized nature (Koyre, 1989, p.107-109). According to Schuster's view, the Science Revolution is the triumph of the right metaphysics for Koyre, while for Hessen the solution of the technical needs of rising capitalism (Schuster, 1996, p.220). The given dates for Scientific Revolution are very open to question since Chinese and Islamic astronomy have made systematic studies and produced scientific production in the previous years, so the earliest century can be the seventeenth century for the date when revolution began (Brennan, 2004 p.204-205). Chinese astronomy mentioned sunspots before Galileo (Tekeli et al., 2018, p.2). The universe models developed by Copernicus were innovations only for Europe (Doğan, 2010, p.144). In China, the sun and moon calendars were prepared in 1400 BC and these studies were conducted to determine the seasons (Doğan, 2010, p.55). The astronomical observations of the Egyptians remained purely from an intellectualism and they were just practical time calculations (Ronan, 2005, p.16). The Egyptians made progress in astronomy, time

measurement and calendar applications, developed the first solar-based calendar of ancient times, and carried purely daily, practical purposes, and were not interested in scientific astronomy or astrology except for short-term astrological interest under the Persian occupation (Doğan, 2010, p.37). Fara argued that the stellar observations at the root of this science were not based on a scientific purpose, that they were only trying to understand the effect of stellar movements on the earth, and that they were therefore making meticulous calculations, an following years, the Hellenic scientists in Egypt developed this Babylonian astronomy (Fara, 2015, p.20-35). In Chinese astronomy, although there was no religious understanding, star positions have been tried to be determined for astrological purpose and moon and sun calendars have been developed for the determination of seasons (Doğan, 2010, p.55). Chinese astronomy focused on the stars instead of the sun and the moon (Tekeli et al., 2018, p.2).

Dogan stated that Mesopotamian astronomy started with the sky, which was based on religion with Sumerians and mysticized as a realm of Gods and then it was proceeded with serious observations mixed with astrology based on serious meteorological predictions by imposing a number of Divine roles on the observed planets. Greek and Islamic astronomy has stated that it provides very important information (Dogan, 2010, p.20-21). According to Ronan, in the prehistoric civilization, science was based on nature and spirit (Ronan, 2005, p.7). Koyre remarked that, in terms of astronomy, it is not true to evaluate Mesopotamian development scientifically, the Babylonians fail to get rid of astrobiology, therefore, the Greeks who succeeded in this should be the precursors of this science, others should be classified as a failure for constructing theoretical structure and just fortune telling (Koyre, 1989, p.78-79).

Although mathematical analysis of Chaldean priests did not develop a planetary theory by applying astronomy in a very different way from the Greeks, their studies using mathematical knowledge on the motion of a planet enabled them to prepare their tables in the most detailed way to determine the future location of the planets (Ronan, 2005, p. 43). Ronan argues that what was done in Mesopotamia should be seen as science because they tried to associate their observations with their reason and that the correct information they have identified have been continued to be associated and explained due to reaching the knowledge that did not count as magic (Ronan, 2005, p.7-8). Adıvar pointed out that there was a religious plan behind these developments in Mesopotamia and added that the main reason was curiosity, however, it was very difficult to distinguish what they had been looking for in terms of 'secret knowledge' as religion and science (Adıvar, 2012, p. 19-20-21).

Wootton argues that it is not easy to define the ‘Science Revolution’ and that there is still no consensus (Wootton, 2019, p.29). According to Bumin, referring to Lenoble, the revolution took place in 1632 when Galileo published his Dialogues on the Two Great World Systems, where the discussion of a topic to be asked to the philosopher at the shipyard seemed harmless, but showed the change of mindset (Bumin, 2016, p.19). Koyre stated that both Galileo and Descartes' science was considered as the science of craftsman and engineer, but this explanation did not seem satisfactory to him. He stated that they were not the ones who learned their sciences from the workers in factories or shipyards but taught them their jobs (Koyre, 1989, p.107). The science put forward by Galileo and Newton was based on careful observations rather than theological and speculative explanations (Özlem, 2016, p.75). Modern science has replaced theory with

correct (certain) knowledge and has always made it indisputable for discussions which makes it open to development, not being strict (Wootton, 2019, p.374-395). This new type of thought, philosophy, religion, legends, such as spiritual and handicrafts are outside the practical efforts (Yıldırım, 1999, p.14), and, on the contrary the obvious technological tool in the determination of this new intellectual tool is not easy (Wootton, 2019, p.524). Henry pointed out and added that the Science Revolution should not be considered a revolution in science, because a concept equivalent to its present meaning has never existed in the past; "When medieval philosophy of nature was combined with mathematical and more utilitarian or experiential crafts and sciences, which were other ways of analyzing nature, which tended to stay away, something closer to our notion of science has emerged" (Henry, 2011, p.5). According to Kuhn, the effort of ordinary science faced some problems and then tried to solve them which led it eventually reaches science with new principles, which is the process of scientific revolutions (Kuhn, 2019, p.77). According to the schematic representation given by Özilgen, observation-based hypotheses are established first, and after they are supported and compared with the experimental results, the theories are made if they are consistent, and if they are not, the way to give up or change is made (Özilgen, 2011, p.110). Experimentalism developed under the influence of craft and an intellectual transformation in which mathematics was based on traditions, which was provided by adhering to tradition, was the structure to which the scientific revolution was connected (Mason, 2013, p.108). However, the philosophy of British experimentation does not exactly coincide with that of continental Europe, that is, the emergence of modern science was not accompanied by itself (Henry, 2011, p.49-50). In the 18th century, in the UK, empiricism and related engineering

disciplines came to the forefront, and a number of new methods in the iron industry were developed by using a number of techniques such as melting iron and casting in sand molds using coke instead of wood, and prepared the way for the industrial revolution. In France, more attention was given to activities focused on theory or spreading the enlightenment (Mason, 2013, p.256-259).

What gives science its basic character is the search for causes of facts and the effort to draw formulas that try to express everything by laws (Dilthey, 2012, p.83). The principle of classical determinism within the concept of causality was destroyed by the quantum and relativity, especially in the modern age, and the concept of cause, which was also proposed by Kant, became ineffective at micro level and began to be replaced by the 'concept of probability' (Yıldırım, 2002, p.128).

According to epistemologists, separating science from non-science was not easy (Henry, 2011, p.47). Yıldırım points out that it is difficult to distinguish between common sense and the concepts of science and that the boundary is blurred from time to time; unlike the common sense, science draws a limit by expressing its cautious structure and fact, which avoids the inconsistencies, and often by questioning and correcting the truths accepted by the common sense. Science, however, all the views that seem close to the public mind by questioning their own methods, rejecting the most powerful and accepting new truths draws a boundary between (Yildirim, 2002, p.24-25). Özlem also stated that the concept of common sense / sympathetic sense is not critical and cannot adapt to what science confirms because it does not need to be based on facts (Özlem, 2016, p.15). Koyre pointed out that, even when common sense is combined with daily practice, it is a much more coherent scientific theory than those proposed by Aristotle

compared to the theory developed by Galileo, and added that ‘‘even today common sense is Aristotelian and Medieval. Aristotle's physics is based on sensible perception; therefore, it is fundamentally opposed to mathematics. This refused to replace the qualitatively determined phenomena of experiment and common senses with geometric abstractions’’ (Koyre, 1989, p.145-146). This interpretation was taken one step further by Kuhn, according to him, when Aristotle's dynamics or chemistry were taken as a whole, they were no less scientific or less product of personal choice than the ideas that exist today or developed after them, and it does not mean that the ages of these sciences have pasted should be considered as nonscientific (Kuhn, 2019, p.73). Adıvar explained what was done by Galileo firstly by separating the nature from human mind and evaluating it independently and mathematically as the time and space concepts being the most important elements in Aristotle physics and he stated that Creative power exists in mathematics in this system (Adıvar, 2012, p.161). Westfall stated that Galileo could not sever all his ties with the past and that the concept of movement he developed depends on the elements of old cosmology and circular motion theories, the product of perfect reason (Westfall, 2015, p.33). Fara, who gave Galileo's contribution to science, stated that his transformation into a science martyr was entirely the work of the people were called by Fara as science propagandists, and that it was an experience of the 19th century, and that he was a dark Catholic who could find support and followers in the Church hierarchy, then Fara also added that this was not a conflict of science and religion, however a result of a much more complex struggle of power (Fara, 2015, p.163-164). Adıvar pointed out that especially the 17th century scholars did not engage a conflict between religion and science and that they could manage the relations between theology

and science in a healthy way (Adıvar, 2012, p.180). The process of Galileo's trial by the Roman church was not the conflict between clergy and science, that is to say, a religion-science conflict, but rather the resistance of university academics to the new paradigm, since they were disturbed by the ideas developed by Galileo that went beyond Aristotle's interpretations (Westfall, 2015, p.138).

According to Sayılı, while scientists are organizing experiments besides the selectivity to be made due to the personal interest, that they will be bounded to some theories as a pre-acceptances (paradigm for Kuhn) and results will be evaluated with these paradigms (Sayılı, 1999, p.16). For Kuhn, the existence of paradigms is a prerequisite for the creation of a particular research tradition, yet teaching these paradigms to students is the most important tool that prepares them for the community which they will be members of in the future and enables them to do their work adhering to the same criteria and in-depth examinations (Kuhn, 2019, p.99). Sayılı stated that paradigms are important for thinking and that they are needed in experiments designed for observation of nature (Sayılı, 1999, p.44). Popper insisted that there must be a theoretical premise for observations (Gillies, 2018, p.26). Kuhn said that there is a need for 'the first paradigm' in the perception of nature and that there can be no independent research after it has been formed, and added that if a paradigm is rejected and nonreplaced by a new one, it will be the rejecting of science (Kuhn, 2019, p.168). Discussing the artificial intelligence experiment called BACON.1, Gillies says that the biggest problem here is that this ‘machine learning’ system is that those who upload it to know Kepler's law, but developed it in spite of the prevailing paradigm that Kepler learned of his own laws. If the data of the Ptolemy paradigm were entered in the

BACON.1 experiment, the result would be in accordance with the paradigm and the software would not adopt the Copernican theory itself as Kepler did yet system' logic would not be included a Pythagorean philosophy, Neoplatonism or kind of worship to the sun (Gillies, 2018, p.69-72). Sayılı thought that it is not necessary to replace a paradigm with a new one, but stated that science and paradigms cannot be mentioned in an environment where there are no paradigms (Sayılı, 1999, p.44). Mason pointed out that during the Protestant and Catholic counter-reform years, Copernicus and Ptolemy theories were evaluated independently of scientific methods with the accepted beliefs of the period (Mason, 2013, p.559). Kuhn states that scientists could not be a scientist by changing paradigms in the slightest difficulty, so that it would be normal for the work to be done first as the paradigm to be arranged or patched (Kuhn, 2019, p.166-167). While falsifying experiments are a complete success for Popper, they are important because they will bring scientists to new problems and new worlds through new theories (Popper, 2019, p.103). In chemistry, phlogiston theory was not abandoned as soon as the first counter-samples were taken instead of the results supporting it, but instead it was tried to continue its validity by patching it with a new phlogiston theory which was defined as a mysterious feature by Sayılı (Sayılı, 1999, p.38-39). Phlogiston, just like density, brightness, malleability, such as a general feature of metals was considered (Hankins, 2007, p.94) and self-burning, in the sense of ignition has been used as a Greek word (Jaffe, 1976, p.28). The theory was first developed by a German medical professor Joachim Becher from Mainz, with the revival of the German school of chemical medicine, in which Sulfur, Mercury and Salt, which correspond to the three core theories, contain all substances which can be slightly modified and burned as *terra pinguis*, *terra*

mecurialis and *terra lapida*, Afterwards, Georg Ernst Stahl (1660-1734) by *terra pinguis*, 'Flojiston' was changed to escape during the combustion of oxidized dust remains in one and all the burns were also found to be abundant (Mason, 2013, p.274-275). Becher stated that chemistry students should be educated both in terms of nature philosophy and in a way that they could work in the laboratory (Moran, 2005, p.149) and Becher started his studies by the Dutch Government during the war between France and the Netherlands (Jaffe, 1976, p.25). Becher believed that quicksilver 'mercury' is at the core of all metals, while Johan Kunckel declared that he extracted mercury from all metals (Greenberg, 2003, p.13).

In Germany in the 17th century, alchemist Johann Friedrich Böttger and mathematician Count Hans Ehrenfried Walther von Tschirnhasun, together with the mineral smelting studies, obtained a different kind of *arcanum*, that is, the formula of hard porcelain which was based on the knowledge of sintering and melting points of various stones of Böttger, then as a result of Böttger and Tschirnhaus's knowledge to develop lenses to use it furnaces benefit from the sun, the first factory in Europe of this type of porcelain was established in Dresden in 1710 (Moran, 2005, p.148). The tradition of alchemy, based on hundreds of years of research and developing new equipment, has succeeded in the separation of ammonium sulfate, which was the raw material of the artificial fertilizer industry, and was essential especially for experimental and further industrial applications (Fara, 2015, p.125). In the meantime, in the first years of the theory was skeptics and refutation studies have done (Jaffe, 1976, p.28-29).

One of the reasons for the difficulty of paradigm shifts is that it also cancels the solutions that were thought to have been solved by the previous paradigm (Kuhn, 2019,

p.248). Carl Scheele, who is thought to realize the importance of oxygen for the first time in his experiments on air, did not think to abandon the phlogiston theory immediately (Mason, 2013, p.277). Popper also said that accepted assumptions cannot be eliminated for nothing and there must be a need for a number of reasons, which can be the result of developing a more testable assumption or falsifying preconceptions (Popper, 2019, p.78). Hankins stated that the chemical revolution has three main precursors, the first of which is the studies and determinations made on gases and vapor phase, the second is the 'discovery of air' and the understanding of the nature of air chemistry that teaches the content of air could be formed by different chemicals, and finally the nature of combustion (Hankins, 2007, p.93). According to Perrin, the Chemical Revolution was the development of a new combustion theory based on oxygen rather than the combustion process of the Phlogiston theory. However, he added that the Chemical Revolution is still being discussed by historians. Perrin also remarked that two facts must be understood well and the first is, he said that combustion was not an issue that chemists were interested in at the time of the revolution, thus it is necessary to understand how it entered such a powerful interaction, and secondly that Lavoisier's work was discussed independently of the content by creating a continuum and an exaggerated rupture (Perrin, 1996, p.264). Experimental chemists such as Joseph Black, Henry Cavendish and Joseph Priestley, who led the collapse of phlogiston theory as a result of their studies, did not stop adopting this theory in their studies in fact, Priestley discussed this theory Lavoisier until he died (Mason, 2013, p.276-284). As Kuhn pointed out, despite having common tools in 19th century chemistry thanks to Dalton's paradigm, they continued to have disagreements in their work and discussed the existence of the atom (Kuhn, 2019, p.284).

With the introduction of atomic and molecular theories in chemistry, new problems emerged for scientists (Sayılı, 1999, p.23). In Sayili' opinion, the connection of new ideas with the past was strong, and according to him, there was a strong connection between new ideas and the ancient ones (Sayılı, 1999, p.60). However, Lavoisier, while introducing the new chemistry theory, emphasized the revolution by burning Stahl's and others books related to phlogiston theory due to breaking the bond with the past (Mason, 2013, p.280).

1.2. History of Science

According to the definition made by Sarton, History of Science is a description of the development of systematized positive information (Sarton, 1997, p.19). In his definition, Yıldırım said ''the birth and development of science'' (Yıldırım, 1999, p.13). Koyre's suggestion to the history of science is that it comprehends the activities of thought that are connected to and transcend societies that reveal and nurture and hinder its development (Koyre, 1989, p.189). The study of the History of Science is also important because it is one of the basic efforts of the Philosophy of Science to understand science (Aksoy, 1994, p.7). In his approach to the history of science, Adıvar pointed out that although at first glance it seems to be right because they seem to be alone, it is wrong to perceive the personal history of great scientists as a matter of fact, and that the developments in the sciences are largely based on other discoveries, inventions, or ideas that have begun stated that the result (Adivar, 2012, p.196).

History of Science is primarily a new discipline, and in 1917 at the beginning of the 20th century, the first lecture was given by Belgian George Sarton at Harvard (Wootton, 2019, p.30).

Prior to Sarton, Paris was the center of the study of science history from the end of the 19th century to the work of the chemist Marcelin Berthelot and the philosopher of history Paul Tannery, then this tradition had been continued by Helene Metzger and Alexandre Koyre in the following years, by the way especially Alexandre Koyre in the following years worked at Harvard, Yale, Princeton as a result has influenced the American school of history and philosophy seriously, as can be noticed from the examples of Thomas Kuhn, Charles Gillispie and Richard Westfall (Christie, 1996, p.16-18). ISIS (*International Review of Science and its Cultural Influences*) began publishing in March 1913 under the editorship of Sarton (Neu, 1967), and the magazine continues to play a leading role in this field. Its lasted version was published by Chicago University at June 2019 with open access for some articles. Christie draws attention to the multidisciplinary role of this education when it comes to the writing of history of science and stated that employees in this field do not progress their careers linearly with the studies they take on science history and that they come from studies in different fields of science, philosophy, sociology or history (Christie, 1996, p.16). Laudan said that the pioneers of historiography of science were in the works of Priestley, Smith and Montucla in the late 18th century, and that the study of the history of science and philosophy of science, especially between 1830 and 1930, continued to develop and work together, they tried to understand what science should be by philosophy studies (Laudan, 1996, p.47). Schuster, who set out from Koyre and Hesse, drew attention to the fact that different historians of science have focused on the different aspects of the above-mentioned Science Revolution, for which there is no agreement yet, and that for Koyre this process is an intellectual revolution and Platonic metaphysics plays an active role here, on the

contrary, for Soviet historian Hessen, it was an effort to respond to the socio-economic needs of Newton's physics era founded, and in a way he was looking for answers to the technical problems encountered in mining, shipbuilding, artillery, navigation and cartography (Schuster, 1996, p.218-220).

While Sarton said that all kinds of history have has to be begun with history of science (Sarton, 1997, p.20), Fara, who recently wrote, evaluates that it is the the history of everything: modern science, technology and medicine are interwoven; it is part of a gigantic network with all other humanitarian activities in the world ((Fara, 2015, p.16). According to Acot, there are two different definitions of the History of Science, the first of which is the development of sciences in particular, while the other definition is the overcoming of the philosophical and epistemological problems posed by the effort to take over these particular histories, the subject of which is both the intention, purpose or objective of these sciences (Acot, 2005, p.7). Feyerabend, instead of explaining the functions of present-day situations, drew attention to their formation processes, their past and what benefits they have provided to people in the past, that is, their gains and of course all the benefits and disadvantages of the lost within them should be known (Feyerabend, 1995, p.91).

Sarton pointed out that the process of acquiring and systematizing positive information is the only human activity that can accumulate and progress (Sarton, 1997, p.19). Wootton states that this process is not only cumulative but also spooler; ‘‘The past not only shapes the present; in the past, the achievements of science were dispensed only in exchange for the greater achievements of the present’’ this is a history of progress (Wootton, 2019, p.514-515). The inventions made to meet the needs, if they are

functional, create a chain of new inventions and the history of science tries to understand these new products and the processes that make it possible (Sarton, 1997, p.25-28). In his assessment under the title The Birth of Civilization, Ponting said that technological developments may not have been at the center of change (Ponting, 2015, p.61). Referring to Russell, Fara states that change and progress are not same things, the former being a scientific and the latter an ethical process; ‘‘Progress is controversial but change cannot be doubted’’ (Fara, 2015, p.413). Sayılı has been one of the supporters of the progress in science and claimed that progress is one of the most important elements of science and that scientists of a period rose on the shoulders of the previous ones (Sayılı, 1999, p.20). Kuhn stated that the term science is a term devoted to progressing fields (Kuhn, 2019, p.261).

According to Yıldırım, two different views, which are considered as the origin of scientific development, emphasized that there are neither theoretical thought changes alone nor a chain of inventions that are listed one after another, furthermore telling the radical changes in the theoretical level and the process of producing and reproducing slowly and continuously progressing knowledge (Yıldırım, 1999, pp.15-16). According to Acot, there are three main problems in the history of science and these are primarily the solution of the concept of disconnection-continuity, the understanding of the development of scientific theory and the solution of the problem of scientific discourse and ideology (Acot, 2005, p.39). Henry argues that the concept of the Science Revolution is a *whiggish*[1] structure because it is to understand the conditions under which science is a decisive element in today's culture (Henry, 2011, p.3). The term put forward by Herbert

[1] Whiggism: Constructing the past to form the concepts of today

Butterfield explains that all the readings that see history as a process of progress will falsify the past and cause them to exclude the many facts that stand before them (Laudan, 1996, p.56). According to Westfall, the scientific revolution was a process of increasing the number of people involved in science studies and the activation of the role of science in life (Westfall, 2015, p.14).

Sarton summarized the dominant view in the study of Science History for a long time, saying, 'Since Jewish and Christian thought affects our world, Indian and Chinese science means nothing in the western world' (Sarton, 1997, p.126). However, it is not correct to regard science as a process specific to the western world or a post-Renaissance product (Yıldırım, 1999, p.13). Throughout the nineteenth century, Europe developed a belief in the uniqueness of its national and cultural structure and perceived it as a means to justify its authority over other rights as a result of the historical process (Elias, 2016, p.31). After Fara blames this Eurocentric approach, he briefly describes it as follows; ''… Science was born in Greece, at the time of the collapse of Europe (according to Sarton, Roman science was merely a reflection of Greek science (Sarton, 1997, p. 21)), which was preserved by the Islamic Empire and remained intact in the twelfth century and then spread to the north'' (Fara, 2015, p.72). As expressed by Acot, between the VIII. – XV Centuries science was Arabs (Acot, 2005, p.73). The Arabs were not only responsible for the protection of the translated information, and writers such as Battani, Fergani, Abu Vefa, Ibni Kurra, Abu Hanifa brought criticism and made contributions to some works such as the Almagest (Doğan, 2000, p.108-111). The scholars of the Latin West were not Greek philosophers actually Arabs educated Latin West (Koyre, 1989, p.11). However, it should be kept in mind that the phrase (belonging to the Arabs) here is

not appropriate when considering Islam. In his critique of Adıvar, he argued that this science should not be called Arab and Islamic Science, but the science in Arabic '*la science en Arabe*' (Adıvar, 2012, p.79). From today's point of view, although the extensive academic production of modern scientific production, especially in the fields of science and engineering, is conducted in English, it is undoubtedly not true to describe all scientific production as English Science or Anglo-Saxon Science in various parts of the world. Actually, it is just science and engineering. As for the transfer of scientific production, for example, the Old Turks used the 60-based system used in the Mesopotamian civilization, which is more geographically remote than the Chinese 10-based number system of the neighboring Chinese (Tekeli, et al., 2018, p.2-7). During the years when the Turks achieved political unity, especially in Central Asia and secured trade, these periods were the times when the flow of information was more comfortable, and it can be thought that the transmitters of the information exchanged transformed this information in their own minds by means of their own methods and transferred it in new ways. According to Fara, it was not possible to transfer the information from one center to another without any change, and under the Eurocentric approach was the 'barbarian' character used by Greek and Roman to define 'foreigners' was used caricaturizing the other peoples (Fara, 2015, p.73). As stated by Mason, the spread of 'barbarian' peoples such as Mongolian armies were effective in the recognition and use of gunpowder in Europe and distilled beverages and glasses were carried by Mongols (Mason, 2013, p.86). At the same time, Germenic tribes and Gauls used soap before Roman did (Tez, 2016, p.9).

Sayili stated that the conquests of the Mongol armies in the Middle Ages were related to their technical superiority, and that the general idea that these armies seized technical superiority by using Chinese and Muslims, and that the Mongols were behind these peoples in terms of intellectual development therefore they did not accept this technique. (Sayılı, 1999, p.82). These people were evaluated depending on their life style which can be defined as nomadic therefore they could not reach these kinds of technology without any developed tribes. Likewise, the Germans who had invaded the Roman lands before had an effect on the Roman civilization, and they put trousers instead of toga, butter instead of olive oil, felt making, and some practical craft techniques such as skiing, keg and boat making. However, as Mason stated, these 'barbarians' developed Roman agriculture by introducing rye, oat, bony wheat and hops, and also used the heavy wheeled plow which was required by three terrain system (Mason, 2013, p.88). The changes they made on agriculture led to an increase in yield in a short period of time, and led to the purchase of more crops from the plantation, and further improved their agriculture by incorporating the horse into the agricultural production with the help of these northern 'barbarians' harnesses and horseshoes, saving time and labor (Mason, 2013, p.89).

As stated above, this 'barbaric' interpretation has been made for a long time while evaluating other peoples based on the idea that they will be incapable of making any contribution to the development of humanity. Peoples, such as Mesopotamia, Egypt, China, and India, who have been out of the Greek civilization for many years, have begun to be appreciated in the past.

Although these developments were seen as the products of technic or craft, they would give a new direction to social relations with the impact they would have on the society life in time, leaving an impact on the cultural life and consequently the mentality or 'spirit of the age'. As stated by Mason, these developments have affected trade in Europe, which has made progress in maritime and led to the development of products based on industrial production (Mason, 2013, p.92-93). In the process of revival of medieval science, the development of craft and trade is one of the main reasons for Mason (Mason, 2013, p.97).

The idea which was described above is of great importance in assessing the place of the history of Central Asia in the history of science. As it is known, the Silk Road has been connected to the Chinese and Western world for many years, and this road has remained in the hands of these nomadic, semi-nomadic peoples of Central Asia.

As the historical sources pointed out, the Turks who established states in this geography gave importance to commercial activities and lived in cooperation with the most important traders of the region. The Turkish peoples and Turkish states may have played a role in the transmission of science and scientific production and the dissemination of ideas when they are investigated with the geography where they dominated. In doing so, as Fara puts it, it does not seem possible that they did not contribute to these ideas, and that they transferred them as exactly what they were without developing or any changing. According to Sayili, in Europe and the wider Islamic State, science is spreading over a very wide field, which is mainly due to the interaction of people and people engaged in science (Sayılı, 1999, p.25). By using this statement; considering Turks contribution to the interaction of the scattered peoples in

the region, as well as the secure interaction of many foreign peoples, which established large empires in the region of Central Asia from Iran to China and even India, and tried to maintain the trade, it does not seem fair to think that they have no place in the history of science.

Sarton, who was considered as the founder of the history of science, suggested that while considering and evaluating scientific success, scholar should continue the forms which can also follow for artistic success. He emphasized the importance of evaluating science, which is a much more ambiguous employee than art, not only in abstract terms but in human terms (Sarton, 1997, p. 112). What makes people do science is the ability to abstraction (Koyre, 1989, p.27). Dilthey shared a similar view and said that before science, man wanted to create singularity through art (Dilthey, 2011, p.21). Introducing Da Vinci as an artist engineer, Koyre said that his biggest shortcoming is the lack of abstraction ability, although Da Vinci grasped motion, he could not express the law of acceleration, he could not express the semi-tangible situations that he saw in an abstract way (Koyre, 1989, p.100). Art and science think by establishing symbolic images, the starting point of both is the imagination of people (Yıldırım, 2002, p.155). According to Sarton, the difference between the two is not qualitative but quantitative (Sarton, 1997, p.119). As stated by Yildirim, the history of science has to include mythology, religion, art and metaphysics in terms of its relationship with science (Yildirim, 1999, p.13).

Although mythology represents the first stage of the formation of religion and science, especially in Mesopotamian science, it had played a crucial role in explaining the myths created by these peoples, which were mostly based on celestial movements,

that was, the creation of the universe through the legends (Adıvar, 2012, p.20-21). One of the common characteristics of art and science is that they are ‘established’ and that they are ‘establishing’ continuously based on the changes /developments of culture (Ülken, 2007, p.4).

Art is especially prominent in a subject like the Old Turks. As a result of archaeological studies, clothes, jeweler, weapons, paint usage examples, and nutritional habits can be found both in terms of their artistic aspects and as a part of the process of sustaining their lives. However, the written and oral literary sources produced can be another guide of such studies with the information given on their lives. Cultural findings, which are seen as a part of artistic production, can also bear the first traces of a possible proto-scientific culture, both as technical and as mentality.

2. CHEMISTRY AND HISTORY OF CHEMISTRY

The difference between the branches of science, due to the diversity of examination subjects and a number of specific techniques required by these issues occurred (Yıldırım, 2002, p.66). One of the places where the modern meaning of chemistry was first emphasized was the eighth article of the Manchester Literary and Philosophical Society charter during the presidency of John Dalton; ‘‘The subjects to be discussed include the philosophy of nature, theoretical and experimental chemistry, decent literature, civil law, trade and arts’’ (Mason, 2013, p.261). The first claims that chemistry is the science of original qualities related to internal properties were made by Jaber ibn Hayyan (721-815) and he concluded that the experiment could not be a coincidence as a result of the experiment where he observed that the vinegar lost its sourness when he added lead oxide vinegar (Doğan, 2010, p. 112). According to Aksoy, Chemistry broke with Philosophy and declared its independence with Lavoisier in the 18^{th} century (Aksoy, 1994, p.48). Kuhn considered the situation here as the adoption of a new paradigm upon the deformation of the prevailing chemistry, namely the prevailing paradigm. He stated that the process is based on the problems related to air that started with the development of air pumps a century ago and that the formation of phlogiston theory as well as the number of chemists indicates is the crisis (Kuhn, 2019, p.155-158). Chemistry has not been like astronomy, which has made serious progress especially since the years before Christ, and it has not gone beyond being a purely craft production before these years (Adıvar, 2012, p.23). The distinction between chemistry and alchemy contributed to serious discussions, especially in the Islamic State in the Medieval Ages, and numerous experiments by the parties led to the emergence of new data that could be

used by successors (Tekeli et al., 2018, p.148). In his book, Alchemy, a German named Andreas Libavius (1555-1616) showed and introduced the necessary laboratory procedures and equipment which would be considered the subject of chemistry directly today, but not only in how pragmatic chemical changes occur with different substances, the definition and understanding of alloys by quantitative methods by giving empirical and useful information (Moran, 2005, p.8-9).

It was found that a mummy in Hanon, China, dating to the 2nd century BC was not subjected to any embalming process, but remained extremely well preserved. However, it was found that the body was filled with mercury and sulfur in the protection of this body and then it was preserved in an oxygen-free and completely natural low temperature in a second coffin containing high pressure methane gas whose mouth was covered with coal and white clay (Doğan, 2010, p.57). This shows that they WERE aware of the information that is the subject of today's chemistry. According to Dogan, despite the chemical applications that require advanced chemical knowledge, the founder of experiment-based chemistry and alchemy is Gaber, who lived between the 8th and 9th centuries (Dogan, 2010, p.191).

Today, as a part of the engineering discipline, chemistry, as in the past, is manifested in most of the production processes. The development and production of the instruments that human beings use to make their lives easier, the foods that they need to maintain their lives in a healthy way and the medicines that provide treatment in case of illness take place at the end of the processes involving the disciplines of chemistry and chemical engineering. The distinction between Chemistry and History of Chemistry is the reduction of the above distinction between science and history of science from

general to specific. Chemistry, as a scientific discipline, has not developed into a present moment and has been influenced by both mental and technical transformations covering many years. Adıvar stated that the most important development in terms of the formation of modern chemistry was atomic theory developed by John Dalton at the beginning of the 19th century, and another major step after his ideas was the creation of a part of the periodic table by Mendelejeff (1834-1907) (Adıvar, 2012, s.12-13). A century before all of these, chemistry was seen as an entirely unnatural and mystical occupation which was an area of the service of medicine (Westfall, 2015, p.108-109). Just as humanity had to consciously and systematically resort to chemistry in the production and development of tools, the production of certain foodstuffs and therapeutic medicines, which he expected to make life easier today, he used to apply chemistry, even though he was unaware, in his struggle with nature. Beyond that, chemistry was introduced as an application in the production of art, for example in the production of dyes. However, it can be seen that this effect of chemistry in daily life was often the reason for its exclusion.

2.1. Chemistry

The word originates in ancient Egyptian language and is known as 'chem', 'land' or 'Black Country' Greek 'Chemeia', although Greek 'chyma' (metal casting), according to Acot's quotation from *nouveau dictionnaire etymologique,* (black magic) (Acot, 2005, p.75), is also claimed as its root (Tez, 2010, p.6).

Nicolas Lemery, a mechanical chemist, published his work, *Cours de* ***chimie***, in 1675, which aims to explain observations instead of developing a chemistry theory (Westfall, 2015, p.94-95). Although there was no information about chemistry in Papyrus scrolls, it was known that the Egyptians had processed gold, copper and silver since

ancient times and even mixed gold and silver with a white mixture they called 'asem', they knew the process of purifying gold and obtaining copper and tin ores. Moreover, the Egyptians only know about the embalming of the surgical procedures, not with the help of wine or a special herbs made of clotted stone containers with the help of organs, they know to obtain scented resins for the inside of the corpses were also placed in the saltpeter in the final stage for embalming (Doğan, 2010, p.39). In this case, it can be considered that Egypt has at least some practical knowledge of chemistry. According to Mehdi Hassan, the word 'chin-i' used in the meaning of gold making water and the Fukien dialect in this country was pronounced as 'Kim ya' and it was stated that the word was brought to the west by the merchants as a result of the trade with the Arabs in the region (Tez, 2010, p.6). Dogan said that, in his assessment of chemistry in China, despite the fact that the real applications of this science began in a late period, since the ancient times, especially the invention of gunpowder has been made, while contributing to the development of medical and alchemists together as a result of craft activities such as painting and cooking (Doğan, 2010, p.57). Mason pointed out that in the development process of modern chemistry there are innovations and advances in the field of industrial application and in the empirical way depending on agricultural and medical practices and independent of any development in science depending on the trial and error method and also Pharmaceutical production of the occupations which are the subject of chemistry until the 18th century over the pharmacy and leathering, paper production, textile as the heritage of craft (Mason, 2013, p.472). This situation is also important for the Ancient Turks to be examined in the below, in order to reveal their place in chemical applications, although there are no doubt much smaller scale and more primitive techniques. Mason

explained the subsequent change through the bleaching method through textiles. In the past, sour milk acid and plant ashes of the product dipped into the so-called 'bleaching field' is left under the sun and bleached in places, when there is insufficient supply of sulfuric acid is tried in the following years, but not in England but in France as a result of a short supply of soda salt stated that the studies started in this country (Mason, 2013, p.472-473). Buttermilk and vinegar were the well known materials which used for bleaching (Tez, 2016, p.8). In the dictionary of Turkish Language Institution, Chemistry; 'Science which examines the basic structures, combinations, transformations, methods of analysis, composition and production of substances 'is defined and also defined 'very valuable thing with superior properties' and 'harmony' (TDK, 2019). Apart from the definition of superior features, the Oxford dictionary is the same as this definition (Ofxord, 2019). This usage seems to have emerged as a result of a culture belonging to the Turks (Tez, 2010, p.7). Tez emphasized the alchemy/al-chemistry distinction by referring to the work of Adıvar and Hancerlioglu and term al al-chemistry or al alchemie is the equivalent of experimental art and called as al-chemistry (alchimie) (Adıvar, 2012, p.70), he stated that alchemy represents the metaphysical aspect of this experimental art (Tez, 2010, p.6). However, in Medieval Latin there was the word 'chimia' used in the sense of 'chimie' (chemistry) (Acot, 2005, p.75). Alchemy started with Zosimos in Egypt at the end of the third century and it is known to go up to the first century (Adivar, 2012, p. 70-71). According to Henry, the first manuscript in this direction was produced by Hermes and Zoroaster in the Renaissance years and *Corpus Hermeticum* and *Oracula Chaldaica* were be dated to the 2nd to 3rd centuries AD in terms of content Neoplatonist, Neopythogars, Stoic, Persian ideas (Henry, 1996, p.585). Alchemy production of these

years, alchemy practices were burned and destroyed by Emperor Diocletian in 299 (Adivar, 2012, p.71). Aksoy has classified Alchemy as a pseudo-science and together with Astrology evaluation, along with thousands of people who value the pursuit of alchemy said to be seen as noteworthy (Aksoy, 1994, p.61). Moran said that Alchemy should not be seen as something that people believe, that it is an endeavor of mankind and alchemists were the most enthusiastic representatives of nature research before and during the Science Revolution, but that modern society in particular, after the Enlightenment, preferred to ignore a number of serious and practical works (Moran, 2005). 9-10).

Alchemy was considered vital by Newton, who was the great example to define uncertain boundaries of science, on the path to knowledge, and therefore he was a man of great work and incorporating a number of results into his astronomical theories, according to Fara (Fara, 2015, p.22). Newton claimed that some observations, such as comets, could be corrected by intervention by a divine force when necessary (Adivar, 2012, p.211). A great part of the work carried out by Newton was generally accepted by the Anglican Church despite all doubts (Mason, 2013, p.263).

Henry, in the acceptance of the concept of a scientific revolution, emphasizes that alchemy and chemistry tradition is one of the most important sources of the experimental method (Henry, 2011, p.42). Although there are debates about its existence and contributions in the literature, Cabir ibn Hayyan applied experimental methods in chemistry, and by making tools for his experiments and reaching the results with a number of experiments, by the way he also wrote a book called ‘Book fi Kimiya al Iksir’ which was evaluated as the completely chemistry book (Dogan, 2010, s.112-113). The

contributions made by Gaber to the science of chemistry can be categorized as the technological contributions provided by the quantitative understanding and the development of new instruments as a result of its sensitivity to measurement and weighing especially in the experiment (Tekeli et al., 2018, p.149). Court said that the premise of systematic application of chemistry is Rhazes (Court, 2005, p.34). Gaber has used ash furnace, distillation column and still, experimental vessels, ceramic flasks, beakers and scales as experimental tools (Doğan, 2010, p.113). Ancient Chinese Alchemists have realized the reaction temperature which is of great importance for chemical and chemical engineering today and developed and used retorts, ovens and furnaces different from Greek and Mesopotamian samples for reactions (Doğan, 2010, p.57). The sorcerers were essentially the first specimen of the experimental researchers, the elixirs, which were originally prepared with a number of magic or sacred beliefs, after a while, as a result of trial and error and observation, it was understood that the active substances used in time and the non-active ones would be interpreted and evaluated by providing the formation (Ronan, 2005, p.6). The narrative of Chinese alchemists, who are thought to know some serious chemical information and develop experimental equipment, was full of mystical elements and exaggeration about freezing and separating alcohol from water while separating it from water (Doğan, 2010, p.57).

However, many years of Alchemy studies in China had taught them the knowledge of the structure of chemicals, and they discovered that the mixing of sulfur and saltpeter with a technique called controlling sulfur broke the flammability and poison property, and used the powder to kill infection and pests and the this was given by Simiao in the Classic of Alchemy, written during the Tang Dynasty (Yinke, 2010, p.18-

19). According to Doğan, sorcerers were the first chemists in the world to extract minerals from plants and fruits, or mix two substances and produce new colored substances (Doğan, 2010, p.8). el-Kindi was one of the first to protest against the idea that precious metals could be obtained from rubbishy metals and argued that metals found in nature are not compounds and have their own unique properties (Tekeli et al., 2018, p.149).

According to Henry's statement, Bacon-type experimentation was not based on the tradition of mathematics, but on chemistry / alchemy, chemical new medicine, magic and craft traditions (Henry, 2011, p.36). Weber argued that this role of Bacon should not be exaggerated since there were some examples before Bacon, but he argued that he at least saved the experiment from the lower position that scholastic thought gave to the experimental studies (Weber, 2015, p.225). It is known that Hippocrates, the founder of medicine, constructed this discipline on experience (Adıvar, 2012, p.34). According to Doğan, his most important difference is that he adopted more secular understanding of medicine compared to his age and opposed the evaluation of diseases whose reasons were not understood and classified as devil work or the wrath of Gods (Doğan, 2010, p.88). Mesopotamian medicine, even though it had some texts and books, was mostly based on the experience of physicians, essentially God was responsible for the disease and the cleric also engaged in the calming of the drug and physicians were needed to pacify the God’s anger (Ronan, 2005, p.35-36). However, the information obtained from the tablets found in the library of Assurbanibal and the Nebule tablet showed that the preparation of medicines and ointments was made with the use of a number of plants, roots, seeds and essential fluids, which were known to not be based solely on magic. In

addition, although the level of surgical procedures could not be fully understood, its presence was determined. In the laws of Hamurabi, witchcraft has also seen as a criminal response (Doğan, 2010, p.22-23). Experimental tradition in alchemy, preserved and maintained for centuries, was an attempt to determine the dependent variable, that is, the effect of an agent and had a critical role in the determination of active substances in chemical applications (Yıldırım, 2002, p.81). The first alchemists, the Egyptian Zosimos' successors, were the people who knew what they were looking for and also they were the people who wanted to convert precious metals into precious products, especially gold, in accordance with the scientific environment and philosophy of their times, namely socio-cultural life they thought that they did (Adıvar, 2012, p. 70-71). According to Bacon, science made through observations and experiments is the only way to determine the methods of knowing and controlling nature (Doğan, 2010, p.145). Throughout the Middle Ages empiricism was used by alchemy and witchcraft (Henry, 2011, p.34). Alchemy was interested in mystical issues as well as practical things, the field of craft. The pioneers of chemical medicine developed by Paraceleus in the sixteenth century after the Middle Ages were students of Raymond Lull, known as alchemists and mystics, they used alcohol to decompose the essences of the plants for taste, smell, or healing properties, bringing them to medicine (Mason, 2013, p.101-102). According to Weber, Lull, who was also a theologian, naturalist, missionary and poet, was trying to spread the science of the Arabs in Europe and gradually emphasizing nature observation (Weber, 2015, p.197). Seven centuries ago, an Islamic philosopher Abu Bakr-ur-Razi, known in the west as Rhazes, had made the first work on applying chemistry to medicine (Adivar, 2012, p.88). Before that, there were views about the basis of the human body in India, and in this

case, treatment of diseases with chemicals was taken into consideration (Tekeli et al., 2018, p.4). Rhazes has developed mercury ointments for wounds long before European physicians, who are considered the beginning of chemical medicine, has developed suture threads for surgeries from the animal intestines, which he sterilized, and was the first physician to apply cast to the fractures (Doğan, 2010, s. 114-115). Physician Razi from the Rey Hospital, in his most important chemistry studies distilled organic substances and obtained various salts, oils and dyes, as well as melting of hard-melting metals such as iron has made studies (Tekeli et al., 2018, p.151). Razi can be seen as one of the first representatives of chemical medicine as a chemist and medical physician. According to information given by Dogan based on Sezgin, Razi is the second important person in the history of chemistry by J. Ruska consideration, who studies the history of science (Dogan, 2010, p.112-113). Long before Rhazes, during the construction of the pyramids in Egypt, the provision of food such as radish, onion and garlic as a food for the protection of workers from diseases was also associated with their inhibitory effect on bacteria growth, not by the recognition of the bacteria by Egyptian civilization, but by practical medical knowledge and observation which was the result of reasoning (Ronan, 2005, p.16). This determination was made based on the remains of pottery in the environment, and also in the Egyptian documents during the construction of any epidemic disease and the spread of deaths related to it has not been recorded (Dogan, 2010, p.36). Paracelsus's definition of alchemy was to convert raw materials in nature into processed products for the benefit of humanity, and biochemical processes were included and even people such as cooks and bakers were alchemists in his view (Mason, 2013, p.206). When the medical practices in China are examined, it could be seen that

especially Taoist priests used some minerals in addition to plants (Doğan, 2010, p.58). The idea that each disease had its own specific causes and substances that started with it and continued with Helmont led to the privatization of drugs (Mason, 2013, p.213). It can be thought that this situation led to the development of chemistry by sensitizing the chemical practices in the increasingly specialized drug production. Chemists, in the 17th century with the effect of being a professional group in the service of medicine and focusing on drug making, the fields of chemistry seen as a part of the philosophy of nature were not seen as a separate section, the science was not counted and the employees of this field were defined by other nature philosophers as 'sooty experiencers' (Westfall, 2015, pp. 90-91).

Hankins states that until the end of the 18th century, the discipline to be described as ‘New Chemistry’ was not up to the theory of oxygen introduced by Lavoisier, but there was a process in which the word ‘revolution’ was used by Lavoisier and his contemporaries (Hankins, 2007, p.81).

Westfall stated that, in the modern sense before the formation of chemistry in the 17th century, one of the most important problems encountered in chemistry is the idea of 'mixed objects' and he stated that the result of this idea that the number of chemical substances go to infinity, pointing to the existence of a saltpeter was not the identical with the other (Westfall, 2015, p.89). According to Mason, even in the 18th century, chemistry, for example, in the phlogiston theory that this articles leads to a decrease in weight with the tendency to rise, their gravity largely adopted the physical and mechanical philosophy is a sign that it is quite the opposite (Mason, 2013, p.276). In the nineteenth century, the problem of 'mixed objects' for chemistry was not solved and the

accepted view was defined as 'mutual convergence' and it was not possible for the law of 'fixed rates' to emerge as long as it continued to exist, which, according to Kuhn, described the subject as selective convergence (Kuhn, 2019, p.227-228). Jeremiah Richter, who was a chemist in the Breslau mines and the Berlin porcelain factory, was a student of Kant and regarded physical sciences as a branch of applied mathematics, his early work on 'fixed rates' was formulated in 1791 (Mason, 2013, p.413). However, his claim was not accepted by chemists until after the debate between Proust and Berthollet (Kuhn, 2019, p.229). Kuhn gave as evidence to the theory of paradigm shifts in the changes and advances in the sciences, especially the concept of atomic theory. However, Kuhn, who had also found valuable evidence in the discussion of this 'mixed objects' issue in the field of Chemistry beforehand, said that the dialogue between them was essentially a deaf dialogue, where Proust saw nothing but a physical mixture where Berthollet saw a changeable proportional compound and he said that these two are directed to the opposite purposes (Kuhn, 2019, p.229-230). Indeed, Berthollet was interested in the process itself, not in the products of change, and his work had the premise of physical chemists from the second half of the nineteenth century onwards, but he argued against Proust's conclusions about distinguishing mixtures and compounds (Mason, 2013, p.414). Kuhn said that Dalton's paradigm had to be adopted in order for this discussion to come to an end and that what was first put forward by Richter was acceptable, and as a result, chemists actually had a new way of doing chemistry (Kuhn, 2019, p.231). According to Hankins, the model proposed by Proust is not fully accurate at the present time, but it does not change the fact that chemists adopted the use of this theory at that time (Hankins, 2007, p.111). Although Dalton's theory was not entirely

correct, the claim that there is only one atom of each element in the compounds was not accepted later, and the results of the studies by Gay-Lussac and Avrogardo, who searched for the answer to this question, constituted the idea that atoms unite to form molecules and surprisingly the results were not accepted by Dalton until end of the life (Mason, 2013, p.416-417).

According to Hankins, Chemistry was not seen as a separate discipline before the 1750s, and mostly recipes and equipment were taken from a long history of alchemy, but alchemy in terms of both the language and thought structure uses a way that rationalizes nature, rather than complicating, he says. It also states that studies in this area have been carried out by health professionals and physicists (Hankins, 2007, p.81). The article 'Chymie' written by Gabriel Venel (1723-1775) stated that chemistry was twice as inferior in France as in neighboring Germany at that time, since at the beginning of the century a number of applications, especially mineral analysis and metallurgical techniques and the isolation of new materials such as phosphorus has made, Venel looked a little more hopeful and voiced the need for 'New Paracelsus' to revolutionize this science (Perrin, 1996, p.265). His call have responded, and as described above for both, new chemistry theory was announced by Lavoisier with a demonstration in which he burned the books before him, just as Paracelsus did. In fact, Paracelsus, as an alchemist who was out of chemistry, became a sought after role in his own age. The studies carried out by Newton also focused on alchemy rather than being chemical, as expressed by Figala and Petzold (Figala & Petzold, 1997, p.190). Hankins said that although mechanical philosophy was not successful in explaining chemistry-related events, the revolution in chemistry was the result of the net rationalization in process of

traditional chemical processes (Hankins, 2007, p.84). However, given the interactions and accumulation of data, it seems plausible that chemistry has entered the ‘crisis‘ process, which Kuhn persistently expressed, and that it has gained its modern meaning through a new paradigm.

2.2. History of Chemistry

Studies on the writing of the history of chemistry began in the form of chronological writing of abundant material with historians such as Torbern Bergman, Johan Christian Wiegleb and Johan Friedrich Gmelin in order to preserve the knowledge of the ancient eras and then Johan Bartholomaeus Trommstorff, J.B. Dumas, Justus von Liebig, Hermann Kopp, F. Hoefer historians such as the main views of this data in the form of editing (Tez, 2010, p.3-4).

According to Tez, the studies on the subject of the history of chemistry, the end of the 18th century with the Lavoisier described above after the chemical revolution was described as ‘real chemistry’ (Tez, 2010, p.1). According to the Yıldırım, from now on, chemistry has now becoming a quantitative science and the process of determining the law begins (Yıldırım, 1993, p.125).

Christie, while talking about the process of writing the history of science, in fact, all scientists are trained in the framework of the general paradigms of their fields accepted from the past to the present day, the scientific activities of these traditions by either continuing or demolishing the new studies, giving examples of the common field of science, saying that all the common field of work, At this point, Chemistry is the most problematic area in terms of writing its own history of alchemy studies cannot be placed

in a place stated (Christie, 1996, p.5-12). In terms of Petrus Bonus, it was normal that alchemy can be seen as both a religion and a science (Moran, 2005, p.34-35). Alchemy, as explained above, has found space in almost all ancient civilizations. According to Jaffe, it was accepted as founder Bernard Trevisan, whose death in 1490 was influenced by Rhazes and Gaber, in Europe. In Europe, especially the kings and emperors also supported the power of alchemy with the need to make gold, laboratories and experiments in various places as a result of the support and many chemical facts that were learnt as a result of these studies which based on alchemy (Jaffe, 1976, p.1-12).

In the introductory part of his book, Moran examines Alchemy and Chemistry in the context of the Science Revolution, as a result of the general narrative, the triumph of the Science Revolution and science is seen as a triumph of pure logic and scientific method, and it is a part of intellectual darkness that awakens and makes the chemists from their sleep. He emphasized that alchemy, which does not meet these conditions, is not intended to be accepted as a precursor to the history of science, but that it should be understood that Alchemy played a certain role in the way of understanding the world especially because it included practical applications and procedures(Moran, 2005, p.1-7). Tez examined the origins of chemistry under the subheadings of production, philosophy, and alchemy, and the first of these was the establishment of the Art of Practical Experiment and Alchemy through the experimentation and observation methods of humanity from generation to generation, and unlike Alchemy first one focused on real objects (Tez, 2010, p.7-10).

Greenberg considered the fundamentals of chemistry as an ancient tripod, which in turn was a mystical, spiritual, conceptual framework, with four elements, two

contrasts, which would later lead to phlogiston theory, with the distillation and extraction developed by both technical and equipment of practical purpose. Obtaining extracts which are the precursors of organic chemistry and biochemistry today, and finally Greenberg says that it is the art of metallurgical chemistry, which was especially developed by mining (Greenberg, 2003, p.54-55). In 1936, Ernst Rutherford described himself as the Hermes of modern times when he described how he transformed nitrogen into oxygen with alpha particles (Fara, 2015, p.122).

3. ANCIENT TURKS

3.1. Difficulties of Ancient Turks History

When talking about the difficulties of writing ancient Turkish history, Barthold said that it is difficult for a researcher to master all the branches of science and languages necessary to work in this field, that this tribe alone is not enough to understand the history of knowing his own language, because many primary sources are used by other peoples who are neighbors and he also stated that the Turks produce written works in the language of the defeated, even in places where the Turks conquered and controlled them most of the time (Barthold, 2015, p.11-12).

The geographical area covered by the studies of Turkish pre-Islamic history covers the area from Korea and Central Europe to the Balkans, but also the difficulties of chronological construction as a result of lack of resources and the incidents experienced as a result of the harsh conditions of the geography therefore that it is not always very easy to come out (Tasagil, 2014, p.19).

Kafesoğlu said that two points should be taken into consideration when evaluating the Turkish history. It is not easy to evaluate and follow the path of development within a certain time for other tribes therefor efforts of writing the history of the other people seem easier. Unlike many other peoples, Turks did not stay in certain geography in certain time (Kafesoğlu, 2015, p.41). Halacoglu stated, as a result of the spread of the Turks in China, Indian, Persian, Byzantine, Arab and Western (Latin, Germanic, Slavic) faced with or lived in the world (Halacoglu, 2002, p.55). Barthold

pointed out that according to the selected part of Turkish history, the person may have to be a Sinologist, Arabist or Iranianist (Barthold, 2015, p.12-13).

İzgi also drew attention to the difficulties in the studies of Turkish history and first of all, for a long time, because of the fact that Ancient Turkish History was seen as a simple tribal life, it was not worth to work, all the works belonging to the Ancient Turks could not be collected in the libraries, he mentioned that there is no institution to organize the studies in this field. While 42% of the works produced in Turkish focus on political history, only 30% of English production is interested in political history and is particularly interested in social life (İzgi, 2014, p.195-199). Sezer complained that in terms of sociology, the explanations produced by the Western scientific tradition are insufficient to understand Turkish history and insists on the development of new concepts and new approaches in order to understand Turkish history that is broader and transcends these explanations rather than a historical understanding that teaches by Western development (Sezer, 2002, s.189-194). Sezer's approach will be tried to be reconsidered within the framework of a cultural production based on Kuban's approach to the problem of art history within the scope of chemistry history. As Kuban said, the difficulty of explaining Turkish history is primarily due to the fact that there are no other people who have such a central role in history and played such a central role in the history of the World, although they do not have written sources belonging to the nomadic period like other Indo-European peoples and Noting that there were no tribes who have established a state, then he added that; ‘‘we cannot and could not write Turkish history with the structures established on French or Iranian history’’ (Kuban, 2014, p.9).

3.2. Art History Studies in Old Turks and Evaluation of Chemistry History in terms of Cultural Aspects

In the above sections, where both science and chemistry and their histories are studied, it is mentioned that chemistry or chemical practices cannot be separated from craft practices in the past years if some alchemy practices under the influence of mysticism are left aside. Likewise, in this section, some partnerships in the emergence of science and art are mentioned and Kuhn's claim that art and science have separated their ways after choosing to return to the principles of art. Strzygowski, in his study under the title of Turks and the Art of Central Asian Art, expressed that the Turks were blamed that in a unique and independent activity in the field of representative art, and her warned the Turks that Western researchers would not do this if they did not seriously examine their art productions (Strzygowski, Glückgowski & Glück , 1974, p. 16-20).

Kuban draws attention to the difficulty of determining how much of the art produced in Central Asia, which does not belong to the Turks, within a period that can be taken back to the Stone Age, and because of the impossibility of knowing whether a master who worked in a region ruled by the Turkish elites was Turkish or not telling us the meaninglessness of the discussion of which race belongs to art. Even the adaptation of the Turks to the settled life under the Buddhist Manichaeist influences in the nomadic East in the steppes of Eurasia has shown a distinction within itself thanks to the differences in their daily lives, production relations, social orders, beliefs, political and economic movements and most importantly their geographical environments (Kuban, 2014, p.6-8). Duralı said that the correct boundary of the 60^0 east longitude passing through the middle of Aral Sea as the western boundary and the 130^0 east longitude

passing through Yakutsk in the east, the 60^0 north latitude crossing the Lena River in the north and the 32^0 north latitude in the middle of the Hindu Kush Mountains in the south is the Inner Asia where the oldest eras in history were experiencing. In addition, especially around the ancient Chinese, Indian, Persian, even Roman civilizations surrounded by the intersection of civilizations, he says (Durali, 2002, p.342). When considering and evaluating this region, Kuban states that it is necessary to consider and evaluate Turkish nomad who entered different environments within the concept of Culture Environment, and that the works produced in these different environments can be understood by different studies and that imitation of Chinese ceramic in Rey does not make this ceramic Chinese or Turkish (Kuban, 2014, p.12-13). The rulers of a region may be from another culture in view of the history of Inner Asia, and this situation may not separate the production of art of the sovereign from the production of the ruling class alone, nor can it distinguish what the people produce from the ruling class itself or from the social and economic consequences created by the newly established political structure.

Baykara has attracted attention, as a result of the adoption of the nomadic life of the Turks in general because of the fact that they were not the first owner of the place where they lived in the geography of the material seized on them has been perceived to belong to the former owners (Baykara, 2002, p.292). Diyarbekirli also mentioned upon this point, first of all, he said that the nomadic, semi-nomadic life of the Turks should be understood and then pointed out that even Hun, Göktürk and Uygur tombs differed from each other (Diyarbekirli, 1993, p.6-7). İzgi pointed out that it is difficult for the nomads living in the same region to draw certain cultural boundaries between each other due to

the lack of resources, and this problem has remained valid in the relations of these nomads with the settled tribes as well as the reason that they have not crashed into a region (İzgi, 2002, p.463). When evaluating Turkish art, Kuban insisted that the Turkish name should be considered culturally, not ethnic. It is easy to comprehend that the Turks who migrated to various parts of the world have started to live together with different peoples and have established new living arrangements in this direction. It would be right to read Central Asian Art as a common value of a geographic region by referring to Togan, because there was no Turkish art here alone and there is no production in which Turks were not involved, and Turks were the carriers of Central Asian culture as well as other peoples (Kuban, 2014, p.14-19). İzgi claimed that it is a matter of serious controversy about the findings of the excavations and that the needs of different tribes who try to survive in a similar geography could not be very different and that the people living in the same nature have produced similar or the same things (İzgi, 2002, p.263-264). Strzygowski emphasized that it is necessary to avoid pre-defined definitions and patterns in order to understand Turkish art, and to emphasize the importance of 'static forces' to be examined and understood well in order to make an impartial judgment (Strzygowski, Glück & Köprülü, 1974, p.96). Rasonyi drew attention, to understand and evaluate the art of nomadic peoples to use the criteria of settled tribes is not correct and the nomadic to carry with them most of the things available in their hands, wool, leather, mines, clay, bone, wood, such as processing raw materials have made (Rasonyi, 2002, s.366 -369). Strzygowski states that the Turks have to use non-durable raw materials in general because of the Mediterranean nation's museums, such as the work of filling a large number of works indicates that they have no chance (Strzygowski, Glück &

Köprülü, 1974, p.24-25). Rasonyi drew attention that iron rust, bone decay, weaving were disintegrated therefore only goods which uncovered such as gold, silver and partly bronze could be found (Rasonyi, 2002, p.366). Another point pointed out by Diyarbekirli is that the precious mines that can be found in the graves in the geographies where Turks lived were often exposed to grave theft (Diyarbekirli, 1993, p.12). Christian suggested that classical theories cause problems even in understanding the political structure of Inner Asia and suggested a model that rests on the models of Central Eurasian and External Eurasian, nourishing and benefiting from each other (Christie, 2002, p.405-406).

For the ancient Turks, craftsmanship and health practices come to the fore as in other tribes in order to understand the application area of chemistry.

If alchemy, as explained above with examples and often tried to be kept out of the field of chemistry, was the field where chemistry has been applied directly until the process called Chemical Revolution was experienced. In short, chemistry was an endeavor that people made in these ages as a result of their survival efforts, and it was not like astronomy or mathematics.

The emergence of gunpowder in China is an example in this regard, as well as another great invention paper is similarly a craft practice. With the mixing of hemp and ramie plant used in textile today, the production started as a result of the bamboo dimensions and silk being expensive, and then continued with this technique with silk and hemp. However, due to the difficulty of writing, during the East Han Dynasty period, bark, hemp, broken fishing nets and rags were soaked and cut into small pieces, then boiled with plant dust, and pestle in mortar and left to dry on a flat surface or baked in

oven. Afterwards, it has been tried to develop with other natural raw materials such as bamboo, reed, castor, reed (Yinke, 2010, p.21). Primitive people can be considered as the oldest application areas of chemistry because of their nutrition, observing nature in diseases and trying to use nature with their experiences for their own treatment, shelter and war, which is seen as a craft occupation.

Turks, since ancient times, considered to be the most important parts of the history of civilization, China, Indian, Mesopotamia and Iran with the Roman world, both political and commercial relations have maintained continuous. Beckwith drew attention to the fact that the peoples of Central Asia continue their lives with trade, and that they need their environment because of their living conditions and as a result they continue to trade to obtain suitable products (Beckwith, 2011, p.266-268). He also stated that since the early Huns the Central Asian peoples have bought and sold the silks obtained through trade, not war (Beckwith, 2011, p.20). Here, just as Kuban dealt with the question of art history, it seems difficult to determine to what extent the Turks are directly involved in the production. The table of officials named ‘Gong chen biao’ contains information about many Turkish people in terms of origin who took up positions in China (Yıldırım, 2017, p.22). It is known that many Turkish tribes migrated and assimilated into Chinese lands in the history (Taşağıl, 2014, p.41). According to Özkan İzgi, the two post-Neolithic cultures in China, Yang Shao (5000-3000 BC), pointed out that colored pottery was of Central Asian origin. Then, Lung Shan (3000-1000 BC) culture traces of the tribes of the Jung and Ti living in neighboring North China is at least known as a mixed culture of settlers and nomads (Izgi, 2002, p.464). Yang Shao culture was thought originally to be related to Anau (Turkestan) culture and Indo-Germen, but later studies showed that only

the new plates were similar to Anau. Afterwards, the culture of Lung Shan, which took place in the plains of the east, built mud houses and surrounded the villages with mud walls, was seen as the first example of Chinese culture that did not know the mine (Eberhard, 1947, p.20-22). Chinese sources also mentioned that before the Qin and Han Dynasties, steppe nomadic shepherds living in the northern regions of the Yellow River and living in tents started settling and engaged in agriculture and livestock (Otkan, 2018, p.8). Although it was very common in Central Asian history that the steppe migrants settled in the areas suitable for agriculture and continued their new culture here, there were communities who knew how to dry their swamps in semi-nomadic life without preferring them, who were able to make pottery, and sustain their livelihood with fishing and animal husbandry (Jdanko, 2007, p.). When Turks deemed useful, they changed their lifestyle (Roux, 2017, p.46). The steppe livestock who lost their flock started to settle down and started to deal with agriculture (Golden, 2017, p.26). The scattered Hun tribes that established states in the north of China had even kept their own history (Otkan, 2018, p.53). Izgi said that, the ancient Chinese dynasties who were able to use copper, iron, such as the use of metals and the era of writing and the emergence of the predecessor of the Hsia dynasty of a high culture of the Shang 's was the Turkish elites ruling the Chinese (Izgi, 2002, p.466). Yinke states that the bronze culture of the Shang era and the subsequent Chou era has gone through a new stage in Chinese civilization in the development of economy, culture, science and technology, and that the subsequent Spring-Autumn and Warring States were the transition period from bronze to iron (Yinke, 2010, p.2). Esin who connected the origins of the Turkish city which was

established in later years to the proto-Turkish Chou, and she stated that it was the city with tent of the sovereign in the cities so called ‘ordug’ (Esin, 2002, p.129).

Marsadolov said that especially for the place where the Great Steppe Road and Altai-Tuva-North West Mongolia populations live together, especially artistic images, technological developments, innovations and so on things were transferred and spread quickly and the people living in this region were getting closer to each other thanks to the horse (Marsadolov, 2002, p.531). Heyd said that it cannot be known how directly the shepherd and warrior Turkish peoples, who are more semi-nomadic, participated in the Silk Road trade, but that there were merchant peoples living in their countries and that many Turks came to the capital after the direct trade with Byzantine, but this probably means that Sogdian came to the capital as Heyd added (Heyd, 2000, p.17-18). According to Barthold, the trade route between China and Asia Minor starting from the second century BC has had an effect to develop mining from the East, and from the west it has been able to initiate the production of Inner Asian glass (Barthold, 2014, p.23). Turks were not only instrumental in the transfer of luxury goods, such as ostrich eggs to China, but also encouraged the growth of trade between East and West and increased interaction (Golden, 2017, p.165).

The above section showed that Turks and other peoples have lived intertwined with each other from time to time by fighting, trading and even migrating. The situation of Chinese dynasties was important in terms of cultural cohesion. Of course, since the dynasties were Turkish, it was not possible to think that the production made in China during this period was not tried by the Turkish people and that the dynasties that were held in this period and who were thought to be Turkish were completely ineffective.

Thinking within the framework of Kuban's proposition that ‘art is the one who produces it, then it is the one who takes it’ (Kuban, 2014, p.22) would be the right approach to understanding the production of Chemical-Craft in Central Asia.

According to Edward Thompson, he discussed archaeological material about the Huns and argued that the finds obtained would not be possible to use in nomadic tribes and that they should be looted, at least it is very open to disputable (Thompson, 2012, p.17-20). As Togan and Kafesoglu pointed out, the general perception about Turks was that they were ‘nomadic’ tribes (Togan, 1981, p.9; Kafesoglu, 2015, p.32). Roux stated that the nomadism of the Turks and the 'bedouin' of the Arabs should not be confused and that there were lifestyles that did not follow the same laws (Roux, 2017, p.46). İzgi insisted that this concept of ‘nomad’ should be understood as a tool rather than a social level (İzgi, 2014, p.131). Kafesoğlu said that it is not right to call this steppe culture nomad because of the shepherd lifestyle understood from the outside (Kafesoğlu, 2015, p.206).

Sinor, on the other hand, opposed the argument that forest and steppe generations were ‘primitive’ compared to the settled surrounding areas (Sinor, 2000, p.24). As he pointed out, when it was concerned meeting the needs of an entire society, hunting and fishing required technological advancement and the ability to make fine tools, which requires the ability to organize highly complex joint ventures (Sinor, 2000, p.18).

3.3. Life of the Ancient Turks

How the ancient Turks continued their lives has been a frequently debated issue. For example, Radloff, one of the readers of Turkish inscriptions, claimed that this tribe

could not have been a blacksmith because he led a nomadic (Bedouin) life and objected to the information in Chinese sources (Barthold, 2015, p.26). The steppe or nomadic lifestyle was considered as an intermediate stage of failure during the transition from hunting-gathering to agriculture, and it was not thought to be an adaptation to environmental conditions, in particular by horse-taming (Ponting, 2015, p.134). The fact that they were regarded as non-rule communities that have led their lives indiscriminately has created a prejudiced viewpoint towards the Turks. The life of these nomadic communities who lived a simple tribal life was not considered worth investigating (İzgi, 2014, p.197). The result of this view is that the steppe nomadic people were barbarians and the enemies of the urban peoples, whose economic activity is agriculture and trade (Beckwith, 2011, p.280). In fact, steppe tribes as well as their settled neighbors were disturbed (Golden, 2017, p.25). These steppe nomads were generally seen as negative and destructive, but the results of the new archaeological studies demolish these theories of savagery and civilization (Jdanko, 2007). Today, it is accepted that cultures do not live alone and live in a coalition (Strauss, 2016, p.54). Central Asia was a good example because nomadic shepherds could not abandon the farmers (Jdanko, 2007). It was also not seen that Nomads changed the social, economic and political order that had prevailed before them in the cities and settlements they ruled (Klyashtorny & Sultanov, 2013, p.97). The information about the life of the Huns given in Shi Ji is as follows; ‘‘They move around for water and grass. They do not have a city, a place where they live all the time and an effort to do agriculture. However, each one has separated lands’’ (Otkan, 2018, p.58-59). Although most of them were nomadic and on horseback, tribes engaged in hunting in the future, while the some of them engaged in agriculture are determined

(Eberhard, 1996, p.90). In fact, the Chinese people did not consider them as barbaric in the sense that we know for steppe tribes, foreign people wanted to say, they admired the people of the steppe tribes they did not appreciate the same meaning was recorded in the same meaning (Beckwith, 2011, p.294-295). They regarded the tribes of Jung as western barbarians, who were also known as horse breeders (Eberhard, 1996, p.114-115), who were known to build cities and farming (Klyashtorny & Sultanov, 2013, p. 60). According to De Guignes, the Chinese saw their neighbors as 'barbarians' to support the idea that their commitments were null and void (De Guignes, 2018, p.512). It is an exaggeration that these steppe tribes were 'barbarians' and plundering agricultural areas in the form of stray marauders (Jdanko, 2007). Bazin also suggests that Chinese resources should be approached cautiously, as the Chinese felt distant from neutral evaluation of environmental tribes due to their own sense of superiority (Bazin, 2011, p.119). Gumilev's view is that nomadic economies, especially in the 1st millennium BC, are much better organized than the agricultural and settled economies around them (Gumilev, 2013, p.88). According to Ligeti, the Huns were a state of organization and organization (Ligeti, 2011, p.46). This tribe was organized like an army (Grouseet, 2017, p.49). According to İzgi, Turks were the dominant element of Central Asia until the Mongol invasion, but this does not indicate that they were settled by themselves (İzgi, 2014, p.315). However, in Central Asian empires, urban and rural life cannot be separated from each other as in other surrounding empires (Beckwith, 2011, p.282). There was a symbiotic relationship between steppe peoples and urban people engaged in agriculture (Ponting, 2015, p.136). One group of scholars considered nomads as independent travelers and defined them as a traveling lifestyle, while another group

described nomads as wandering pastoralists who did not engage in agriculture or engaged in a limited and secondary economic activity (Khazanov, 2015, p.93). From an economic point of view, pastoral nomadism was a unique type of food production economy in which a widespread and predominant economic activity is a migratory animal breeding species and the majority of community members migrate with their animals (Khazanov, 2015, p.95). According to Beckwith, there was no fundamental difference between the economic and political structure of empires governed by the peoples of the steppe ethnic community and the empires governed by the peoples of the farmer ethnic community (Beckwith, 2011, p.281).

It was said in Mesa'udi's Aca'ib al-world that the Turks were divided into many genera and some of them lived in cities and castles, some lived in tents made of felt in mountains and steppes, and those living in the countryside and deserts were engaged in hunting (Şeşen, 1985, p.57). Ibn Rusteh, an Arab writer almost 1100 years ago, has drawn attention to this situation. When he talked about the Turkish countries and the people of the region, he drew attention to the harshness of the geography and the climate and its impact on these people (Yörükan, 2013, p.165). Similarly, Ibn Fakih drew attention to the climate and stated that the physical structures of the people were affected by the cold (Yörükan, 2013, p.195). Taaffe drew attention to a similar point and especially compared the oasis of desert and steppe oasis, the abstraction and closeness of the first settled and intensive farming, easy-grafted interdependent steppes developed livestock production, stated that these two regions complement each other economically (Taaffe, 2000, p. 37). In the words of Taşağıl, ‘‘steppe economy is a self-sufficient economy above all’’ and they were also miners and metal workers (Taşağıl, 2014, p.30-

31). Nomadic communities also continued to shrink some forms of agriculture (Golden, 2017, p.21). Owen Lattimore, directly quoted by Sinor, agrees and states that this steppe was a self-contained economy that it was not completely closed out after trade, housing and dressing, and even fuel needs (Sinor, 2000, p.19).

These theories were tested by using some chemical methods which were develop for completely another purposes since now, these methods which can be listed as stable isotope method, isotope analysis of carbon and nitrogen atoms, is often used in paleodietary studies. To understanding ancient metallurgy in Inner Asia and Turks, SEM with EDS and also some optical microscopes are employed to understand chemistry and structures.

3.4. Stable Isotope Analysis and Its Application to Sedentary Life of Ancient Turks

As demonstrated by Thorp, the first practitioners of the method were Vogel and van der Merwe with articles published in 1977 and 1978 (Lee-Thorp, 2008, p.925). Regarding the emergence of the method, van der Merwe, two successive Nobel Prize-winning inventions in 1960 and 1961, by Williard F. Libby, the natural radioactive isotope of carbon ^{14}C, and then it began to be used up to about 40000 years for the determination of age for organic materials. The following year, Calvin pointed to the chemical description of the metabolic pathway that carbon follows during photosynthesis. Then, approximately and ironically 20 years after these two inventions came together by using the unknown carbon and plants for Libby and Calvin (van der Merwe, 1982, p.596). Isotope means place equal place inde in Greek, and since its basic feature is the same number of protons but the neutron numbers are different, the atomic number is the same but the mass number is different. Those who decay spontaneously

with a certain half-life are called radioactive, those with a very long half-life are stable, and another area in which this feature is used is paleoclimataolgy studies, and the situations of the world's climate change at different times are handled by fixed isotope analysis from geological materials (Tiwari, Singh & Sinha, 2015, p.67).

Vogel carried out his own study in South Africa and determined the difference between C_4 and C_3 and determined the ^{13}C /^{12}C ratio and determined the distribution of ungulates in animal tissue by measuring the ‘grazer ’and ‘browser’ ratio regarding to carbon isotope (Vogel, 1978, p.298). This regimen analysis method is based on analyzing carbon isotopes of photosynthetic plants that select one of these carbon isotopes, most of which are obtained from the Calvin (C_3) Cycle and the Hatch-Slack (C_4) metabolic pathway (Sullivan & Krueger, 1981, p.333). C_4 plants produce a high biomass per active radiation due to photosynthesis, which leads to higher quantum yield at 30 ^0C and higher CO_2 assimilation with C_3 plants per nitrogen leaf (Evans & von Caemmerer, 2000, p.53). Hechatron, McNaughton and Coleman in their study between C_3 and C_4 physiological, morphological and ecological differences in terms of tolerance and sensitivity on herbivores indicated that the ecosystem is dominated by C_4 plants on a global scale (Hechatron, McNaughton & Coleman, p.306). C_4 biochemistry shows a more complex structure when compared to C_3 and is the result of modifications of many genes, and the usefulness for plants in terms of energy only applies to certain temperatures and certain CO_2 concentrations in the atmosphere (Kellog, 2013, p.595).

Ambrose and Norr first described the method, emphasizing that the dietary and isotope composition of the nutrient should be detected correctly, where $\Delta_{diet\text{-}tissue}$ must be detected, which said that the $\delta\ ^{13}C$ value can be determined from bone collagen and bone apatite, followed by the carbon isotope method C_4 and C_3 plants to use. Their spouses are categorized as pulses, wheat, rice, forest, mountain and lowland meadows, dicotyledonous plants, vegetables, trees and syrups, respectively, the first being marshy, sorghum, corn / millet and meadow (Ambrose & Norr, 1993, p.1 -3). Thorp stated that bio-apatite and collagen carry a protective function, especially for porous tissue and bone tissue that allows microbes and water to enter quickly (Lee-Thorp, 2008, p.929).

Tiezsen and Farge said that the isotope ratio method would provide useful information about the geographical, environmental and biological history of the past and pointed out the use of collagen and bioapatite. They also pointed out that the ^{18}O mark will be informative for the wetland status of the environment in bioapatite, and if the sulfur isotope $\delta\ ^{34}S$ is present in the hair or skin it will also inform the sea and land diet (Tiezsen & Farge, 1993, p.121). The main approach in the use of sulfur is to determine the difference between aquaculture, which is part of the feeding chain in the creek mouths, with the soil sulphate and the value is between -22 and +20% for freshwater and between -7 and + 8% for soil (Svyatko, et al., 2017, p.67). Since the carbon depletion rate of collagen is 10 years and it is found in archaeological sites, it provides a great advantage in this method which should be eliminated seasonal effect (van der Merwe, 1978, p.815). Also referred to by archeology and called the 'canopy effect' and in fact the above mentioned $\delta^{13}C$ is a situation that is encountered especially when depleted in tree or semi-tree regions and must be predicted for the determination of the food chain

(Bonafini, Pellegrini, Ditchfield & Pollard, 2013, p. 3927). Van der Merwe and Medina, in their study of the food network in Amazonia, encountered the 'canopy effect' and found that the North American wooded people in the Hopewell culture did not have a serious influence on the food chains, even though they knew the technology of cultivation until later times (Ban Der Merwe & Medina, 1991, p.258).

A comparison between the recently developed MPI-EVA method for the separation of collagen and the old method 'chunk' results that 'chunk' would be a good choice for well-preserved find bones, but would yield satisfactory results at lower cost, but not particularly in more sensitive and well-preserved conditions such as, Neanderthal bones which have been successfully obtained using the MPI-EVA method, since the old method was not possible (Sealy, Johnson, Richards & Nehlich, 2014, p.69). In Vogel's first study, it was said that the method could be used to gather evidence of changes in dietary habits (Vogel, 1978, p.301).

Thorp argues that this method contributes to nutritional studies by identifying foods that are actually eaten by individuals or by a particular group, by other methods. He adds that for North America, these studies have yielded different results than expected, but he argues that overcoming the effect of post-mortem process on the sample is the most important and unresolved problem for this method (Lee-Throp, 2008, p.925-926). Ericson indicates that infrared spectrometry, X-ray fluorescence and microprobe analyzes in the bone detect the presence of diagenesis, but not the degree of it (Ericson, 1993, p.158). Thor states that there is no agreement on overcoming this situation and emphasizes that protocols designed to solve external effects create artificial tissues, and that particular situations apply to apatite, such as when some separators are incompatible

in another while working in a sample (Lee-Thorp, 2008, p. 931). Sullivan and Kruger succeeded in detecting bone carbonate at the age of 10000 (Sullivan & Kruger, 1981, p.334). Studies for the Egyptian and Sahara desert have failed because of excessive mineralization of the bones and degradation of all collagen (van der Merwe, 1982, p.605). Ambrose drew attention to this situation and said that the sample should be suitable and said that this raw material can be made to be measured and then interpolated over the data found and also summarized in five steps (Ambrose, 1993, p.63);

1. Isolation and purification of an uncontaminated fraction of an animal tissue
2. Quantitative conversion to gases without isotopic fractionation
3. Distillation and collection of gases for isotope ratio analysis of different elements
4. Isotope ratio mass spectrometry
5. Presentation of isotopic data in an usable format

When the developmental process was followed, the first indication of marine nutrition was made by Tauber for Meolithic fishermen, Neolithic farmers and historic Danish fishermen, and the first understanding of the nitrogen isotope required two years after Schoeningeri and one year after DeNiro (Ambrose, 1993, p. 62).

The main problem of the studies in this field is not the hard-to-overcome technological obstacles, but rather the efforts of practitioners from different disciplines to apply the knowledge of one field to another in a different field requiring interdisciplinary work. The reluctance of biochemists and geochemists to paleodietary practices, although they are educated in the field, but archaeologists and anthropologists who are not trained in this field want to work in this field. The problem that needs to be solved is that the

arrangements that provide cooperation should be handled with priority from technological breakthrough (Sillen, Sealy & van der Merwe, 1989, p.505).

In these studies, Ambrose emphasized that environmental and climate impacts should be included in order to obtain clearer results and should be an integral part of isotope analysis in soil, plants and animals. He emphasized that the determination of carbon and nitrogen ratios of non-dietary rocks would provide more complicated and valuable data in terms of climate, habitat and physiology (Ambrose, 1993, p.113). Nitrogen, which determines the ring of the individual being examined in the food chain, taking into account that there will be an increase of 3-6% in each step, the human being is higher than the sea is known to have a broader food chain than land is concluded that the individual's regime is seafood (Svyatko et al., 2017, p.67).

In a study for Ontario, it was found that among the indigenous peoples of the region and the European migrants, one diet was based on millet and the other was fed with C_3 fiber. In addition, with this method to find out when the transition to adulthood living in the region has been obtained findings (Katzenberg, 1993, p.58).

In a similar study conducted for Iron Age in South Africa, precipitation and natural factors have been shown to affect the results, however, significant differences have been found in nutrition in farmer communities (Lee-Thorp, Sealy & Morris, 1993, p.116).

A study highlighted by Van der Merwe is that there is an extremely wide gap in isotopic values between Ohio-based hunter-gatherer peoples and the Upper Mississippi

people who have completely transformed their nutrition into the agricultural community (van der Merwe, 1978, p.816).

Dramatic changes in dietary habits have been observed over time in DeNiro and Epstein's studies for the Tehuacan Valley in Mexico and the results have been supported by Farnsworth (Ambrose, 1993, p.62).

Thorp pointed out that the method has made remarkable progress over time since the mid-1970s when it was first introduced, and that many promising new developments will begin to speak of themselves in the near future, such as high-resolution intra-individual sampling and life history (Lee-Thorpe, 2008, p.942).

It is important that the results of the studies conducted in the Liuzhuang region, especially for the proto-Shang culture, are discussed briefly in relation to Turkishness or Turkish tribes.

In this study, isotope analyzes of C and N were carried out and for this purpose, firstly, three different groups of stone burials, earth tombs and tree graves were found in the remains of people belonging to different cultures, these three groups showed a similar tendency to feeding habits. It was found that they did not prefer sheep and goat as their main sources of food for pigs, dogs and cattle, such as a C_4-based diet, including millet or animal which fed by millet. In addition, it was understood that there were no changes in age and status-based nutrition, and that all elements of the tribe had equal access to the food and that the proto-Shangs had adapted the food chain to the region. In addition, it was observed that only one of the two samples preferred the results of the sea-based and the other one preferred C_3-based feeding, and further studies on isotope analyzes

(Hydrogen, Sulfur, Oxygen, Strontium) for these two special samples are ongoing (Hou et al., 2013, s.2348-2350).

Sulfur is not only related to nutrition but also varies with the geographical conditions of the region. For example, it is probably the result of geology that samples from the Altai and Minusinsk regions gave different results (Svyatko et al., 2017, p.71). Minusinsk region, until the middle of the second millennium BC, were fed in accordance with pastoral feeding, especially during the Iron Age has gained importance in the feeding regime (Miller & Makarewicz, 2019, p.5). The culture that emerged here from the 1st millennium BC is known as Tagar culture and is surrounded by the Altai Mountains from east to Sayan and from the west to the Altai Mountains. The region which has been effective in the Hakas-Minusinsk basin has a hard continental climate and has natural steppes. This situation is often caused by frosts will damage crops vertical migrations to the mountain pastures in the winter is continued to be less snowy places in the winter and examples have been seen today (Bokovenko, 2002, p.518). Eberhard classified the nomadic models in this region into three types, classified them as Turkish-Tibetan-Mongolian and characterized them separately and stated that the Turkish type was the most developed among them, because they did not specialize in the Tibetan-Mongolian model, but instead they specialized in cattle, sheep breeding and horse breeding (Mızrak, 2017, p.112). As a result of the radiocarbon analysis of the Holocene climate studies conducted in North East China, the oldest ancestors of the Chinese civilization indicate that people may leave the region and believe towards the Yellow River due to the degradation of their agricultural productivity and patch available habitat in the middle Holocene stage (Guort et al., 2018, p.109). One of the Chinese dynasties,

the Shang dynasty (1600-1046 BC), for example, in China, instead of worshiping the gods of fertility instead of the 'sky' God in terms of the relationship with the northern nomads known to be known, but it is not definite Turkish (Izgi, 2014, p. 42).

The researches carried out in Tuoba Xianbei north of the Yellow River, 1st century BC and 557 AD, they analyzed the nutritional regime of the region, where predominantly C_3 plant-type nutrition was identified, especially in early and mid-time. In addition, directly consumed by humans or fed, for example, for Eurasia the C_4 plant is generally millet and animals have not been consumed, but agricultural tools have been found in the tombs in the village of Meidai. In fact, according to an archaeological report, burnt pottery samples containing seeds of mite were found. However, in late excavations in Datong tombs C_4 was found to be quite high in the bone chain due to the eaten of plants and herbivores (Zhang et al., 2015, p.704). The results of the $\delta 1\ ^{13}N$ isotope analysis in the studies performed here suggest that the fish should be included in the food chain in all three cycles, where the feeding of the animal protein is probably even higher. In fact, as a result of the analysis of animals in the early periods of dominance of C_3 in later times, especially in the late period of animals consumed mixed C_3 and C_4, which is also seen in humans as a result of the development of agriculture should be the result of a by-product consumption and animal husbandry is seen as the consumption of both fattening and grazing animals (Zhang et al., 2015, p. 705). In the following period, a decrease in animal food consumption and an increase in vegetable food consumption were observed, especially in the millet compared to the middle time (Zhang et al., 2015, p.706).

In the western regions of Bestamak and Lisakvosk in western Kazakhstan, in the scope of the studies covering the middle (2100-1700 BC) and late (1700-1400) copper ages, carbon and nitrogen isotope data were generally found as herbivorous animal protein in the form of milk and meat, and for Bestamak, cattle, sheep and goats were also found to be similar values for Lisakovsk, and slightly higher $\delta^{15}N$ values were found to be the best nutrients of Bestamak and Lisakovsk people, while some individuals were fed with low bone collagen $\delta^{15}N$ value and horse meat and horse milk consumption may have been pointed out. However, the researchers stated that the arid and saline environment may have affected this value however they also noted that the possible difference in the amount of individuals consuming some specific products may affect the results. Miller et al. stated that the results in their comments may point to a food chain difference or an individual choice. For example, they added that the grave of the individual who is thought to be fed with horse meat and milk is different, and that even a class privilege can be thought of, and because of the few materials coming out of his grave, he may also be from the lower class, and more studies should be done to learn how these people change their livelihoods and social status over time. In addition, it was stated that pastoralists revealed that the only feeding regime was not an animal (Miller et al., 2014, p. 535).

The results of Svyatko et al. indicate that males gained more protein than women in Altai, and there are cases of protein deficiency in women (Svyatko et al., 2017, p.71).

Cica, located in the forest-steppe region of Baraba in southwestern Siberia, was carried out in two phases and the results of the first phase (14th-13th BC) bronze age, both pollen, handmade goods and bottom sediment analysis showed that there is no

agricultural production here. The results of the paleodietary studies showed that animal protein was superior to the plant protein in this phase, and the results of the isotope analyzes showed that fish farming was not found in terms of human consumption or fauna, but fish consumption was found in the food chain (Privat et al., 2005, p.442). The results of isotope analysis in southern Kazakhstan do not give an example of the feeding and cultivation of cereals until the first millennium BC since in Central Kazakhstan, the consumption of millets is seen as a part of the pastoral diet (Miller & Makarewicz, 2019, s.5-6). The samples and consumptions of C_4 plants dated to 1800 BC in southern Kazakhstan were reached by isotope analysis method, but it was also seen that they were consumed in a small scale in the early periods and even the nutrition preferences of people living in similar regions were different (Matuzeviciute et al., 2015, p.32). As a result of the isotope analysis of Kamennyi Ambar settlement near the Ural River in northwestern Kazakhstan, there is no evidence that 'domesticated grain' was produced here (Hanks, Miller, Judd, Epimakhov, Razhev & Privat, 2018, p.24).

In the Altai Mountains in South Siberia for Afanasyevo culture studies have also been compared with the Minusinsk region, the results indicate that animal protein based on dietary was here because the absence of C4 samples. If the Sulphur or Nitrogen isotopes were tested to understand that they ate fish or freshwater foods, due to 'fresh water reservoir effect' it is not possible to determine eating the see foods. By the way, results did not match the Eurasia and Minusinsk regions in terms of fish consuming (Svyatko et al., 2017, p.71). Afanasyevo culture is known as a culture of South Siberian origin and of Altai origin dating back to 2500 BC. Taşağıl states that they are the first representatives of Proto-Turkish culture and that Minusinsk region is the most important

area of Andronovo culture dated 1700-1200 BC and spread in East Kazakhstan (Taşağıl, 2014, p.47). Ögel says that the most important part of Afanasyevo culture is the 80 graves in the Bateney region, and the materials recovered here are ornaments made of copper wires and metalworking tools, and he also finds that animal husbandry and hunting are done here (Ögel, 2014 (II), p.18-19). Koçsoy said that this culture is the oldest culture of the Turks defined as the homeland of the Abakan Steppe is another name because of the Abakan Culture and spreading to the Altay Mountains from Volga river which dominates the vast area (Kocsoy, 2002, p.73). Golden says that Afanasevo culture is a culture of Western Eurasian origin, probably from the Black Sea steppes, which came to the Altai and Yenisei-Minusinsk region in the middle of the third millennium BC, and that Turks may not have always been a nomadic people throughout history. In fact, even after late in the 10th century, Hu Ch'iao spook about hunter-fisherman Turks (Golden, 2017, p.55-56). Minusinsk was evaluated by Grousset as the metallurgical center of Altai (Grousset, 2017, p.41-42). Although Golden did not say that this cultural interaction was Turkish, he stated that it had a strong influence on the Turks (Golden, 2014, p.57).

Findley also drew attention to this issue and stated that Turks should not be seen as a typical desert or step nomadic people. He added that the Turks preferred to establish settlements despite the fact that many of the agricultural communities and shepherds lived together in the region for many years, especially in the region where many of the Turks left their nomadic lifestyles in many places for quite a long time and established settlements (Findley, 2005, p.19). On the other hand, all the Turks living in the Eurasian geography did not experience the highland and winter life, and when the conditions were

favorable, they were settled and even in Hakasya it was determined that they lived in tree houses and huts (Taşağıl, 2014, p.37). It is clear the fact that the 'nomadic' lifestyle of the Turks had a very different and developed structure compared to their neighbors would form the basis of their organizational and state-building skills in the later period (Mızrak, 2017, p.113). The settlements of the Hun Turks were identified as 77 in Kazakhstan, 75 in Mongolia, 72 in Altai, and 358 in Tanrı Mountains and Western Turkestan (Vural, 2016, p.39). The hunter-fishermen peoples of the Western Siberian squad spent winters in durable houses dug in the soil and fortified them to form a settlement (Okladnikov, 2002, p.97). Gerdizi said, in his work Zeyn ul-Ahbar, Turks stored meat for winters and in the summers they entered the cellars to protect from heat (Şeşen, 1985, p.89). There is also information in Chinese sources that Huns were engaged in agriculture (İzgi, 2014, p.67). Especially in the most advanced one in Tötö steppe, irrigation canals that require high techniques were also found in the Hun geography (Ögel, 2014(II), p.169). Spengler et al., who participated in this situation in northern Mongolia during the Hun period, also stated that it is unclear how important agricultural production was to these people's eating habits (Spengler, Miller, Neef, Tourtellotte & Chang, 2017, p.306-307). Millet consumption in the steppes of Mongolia was determined during the Iron Age from the isotope analysis results (Miller & Makarewicz, 2019, p.6). As a result of archaeological studies conducted in Noyin-agil and Baykal lake, sickles, ages, cuts, pits for storing products, stones used to crush and grind grains and plows were also found (Vural, 2016, p.39). Togan, in particular, said that the excavations of Nouin-ula and Pahilik Kurgan and their findings shook the thesis that Turks were exclusively nomadic (Togan, 1981, p.25). *Su* (millet) is referred to in

these sources as the first grain they grow for their own nutrition, and in addition, the melon, watermelon seeds and wheat and barley seeds from archaeological excavations also support the resources (İzgi, 2014, p.68). Millet was also one of their main food items (Candarlioglu, 2013, p.44). Wheat was also known (Eberhard, 1996, p.94). According to Chinese sources, they grow wheat so called *pi-mai* (Vural, 2016, p.39). In particular, the Huns used Chinese prisoners of war to deal with the resident economy (Klyashtorny & Sultanov, 2013, p.69). Ögel stated that some Töles tribes going in the West direction had left nomadic life after 429 and started farming (Ögel, 2014, p.20). These tribes did not grow grain before (Yorulmaz, 2012, p.64). However, it should not be forgotten that they learned to grow agricultural products during this period (Taşağıl, 2016, p.48). According to İzgi, the first agricultural product they know is the alfalfa they use to feed their horses (İzgi, 2014, p.68). A number of ruins, plow and millstones found in the Great Wall of China (İzgi, 2014, p.68) It is shown that Huns are engaged in agriculture, even in primitive style (Gumilev, 2013, p.110). They also stored food (Ligeti, 2011, p.49). Huns built warehouses and storehouses with the effect of agriculturalism developing after them (İzgi, 2014, p.68). They had food warehouses in the cities they managed (Klyashtorny & Sultanov, 2013, p.67). This is characterized as semi-nomadism, and predominantly the pastoralist economic structure is the regular migration to new pastures throughout the year or for most of the year (Khazanov, 2015, p.98). The inadequacy of their field prevented them from cultivating their agricultural culture, they were making the soil very deeply, but in Ivolgi ruins about 80 hectares of land were exposed in a square of 75 hectares (Klyashtorny & Sultanov, 2013, p.68). It is understood that there was a highly developed agricultural culture in Uighurs both from the existence of large fruit and

vegetable gardens and from the proliferation of words about agriculture (İzgi, 2014, p.68). The first Uighurs adopted a nomadic and animalistic lifestyle as a result of their living geography (İzgi, 2014, p.84). İzgi, when talking about Ancient Turkish religions, claimed that the shamanic belief originated from agriculture, and that Turks who wanted to get good crops in the cultivated area felt the need to cast magic. According to him, celestial beliefs in Turks began with the transition to animal husbandry (İzgi, 2014, p.4). Candarlioglu points out that steppe culture should not be confused with nomadic culture (Candarlioglu, 2013, p.37). The seasons had an impact on livestock and agriculture (İzgi, 2014, p.78). In this steppe area described above, the Turks lived side by side in certain summer and winter dormitories with certain borders and tribes (Turan, 2014, p.7). They were not strolling for water resources, as Chinese sources say (Golden, 2017, p.21). Groups coming to certain areas by coming together in the barracks were drawn to the summer areas in smaller groups in summer (Baykuzu, 2012, p.19). Each group had a specific region (Ponting, 2015, p.134). This is important that it can be thought that it gave the Turks a sense of homeland. According to Cahiz, Turks were the most homesick in the land of Acem (Cahiz, 2017, p.108). Highland and winter should be considered as a whole, they are definitely parts of a whole (Baykuzu, 2012, p.19). It is possible to obtain information about the slaughtering season of animals by using cementetum annulation method for the studies on the plateau-winter life. The study conducted in Tuzusai (Kazakhstan) indicates that both settled and shepherd people lived in the region or that shepherds came and settled during certain periods of the year (Schmaus, Chang & Tourtellotte, 2018, p.141-142). From time to time, even the people living in the same region could be different, people living under tents and sowing land, people who

searched for pastures and those engaged in agriculture, livestock and never engaged in land could be found in the same country (De Guignes, 2018, p.52-53). In short, the Turks had to live in such a way as to sustain the lives of these animals. This experience also affected their time and calendar concept; they did not make the progress of the solar cycle directly by calculations, but by observing the effect of plants (Bazin, 2011, p.119). Marsadolov tells that the monument to Arzhan monument, primarily according to the direction of the rays in the direction of observing the astronomical values of the equinox and the sunset may have been carried out, and dendro-chronic investigations as a result of the start of the days of spring start counting (Marsadolov, 2002, p.527). This may be the source of the summer pasture-winter quarters life. As can be seen, the correct determination of the nutritional regime of the Turks can give many ideas about their lives, as well as give an idea about the values they are based on when making observations pointed out by Bazin. The fact that science and technology, which is mentioned at the beginning of the study, was not an intellectual process in the ancient ages, and is on the testing and understanding of nature through direct trial and error, can give comprehensive ideas about these experiences of the Turks. Based on whether certain foods, such as fish, have been consumed in similar regions and in culture environments, it can be understood which tribes live similar lives in their migration or in other regions. In addition, information on social hierarchy or the structure of tribes could be better analyzed, possibly for reasons directly related to combatants, in which it is determined that women receive less protein than men. In the first millennium BC, especially in the mountain hillsides in Central Asia, archaeo-botanical data showed that in East Central Asia (East Turkestan) where agricultural materials have a place in the economy before

the spread of Achaemenid, even here in Talgar or in drier places (except Kyzyl Bulak because the botany has not been preserved region) agriculture, a complex economic model has been maintained, but the current situation in the Talgar region is reflected in all of the studies need to be reflected in Eurasia (Spengler et al., 2017, p.306).

A more recent isotope analysis was conducted in the Mongolian period in the region covering the period of the Yüan and Ming dynasties in southern Mongolia. Strontium was found in the mummies in the Hets mountain caves in the Gobi desert in southern Mongolia, indicating that it is mainly fed with dairy products, leafy green plants, sea salt, pods and bone powder. Lead was determined that one of the samples from which this determination was made died as soon as $\delta\ ^{13}C$keratin results. As result of the isotope analysis of the Yuan and Ming dynasties in the region from the other places were detected, this does not have to be a migration from far away. It has also been found that the food chain is strongly dominated by C_3, as well as herbivores fed on the mixed C_3 / C_4 protein line. As described in the research described above (nation) was not found (Turner et al., 2012, p.3137).

4. THE MINING ISSUE OF ANCIENT TURKS FROM THE ANCIENT AGES TO THE PERIOD of UIGHUR & INTERACTIONS WITH CHINESE CIVILIZATION

Davletşin said that the areas where Turkish-Tatars' chemical practices are directed were craft and pharmacy. He said that the first blacksmiths in the Sayan-Altai plateau that produced high-grade weapons using iron from the 2nd century BC were Turkish tribes. He pointed out that this knowledge of metallurgy is not possible without chemistry and technical skills (Davletşin, 2013, p.358). This approach can be used as a basis for understanding the chemistry of Ancient Turks. BC 3rd millenia, Sumerians designated seven technical profession as the celestial which were ıronworking, metalworking, armorer, basteketry, leathering, woodworking and the construction business, they also protected by God of Wisdom Enki (Tez, 2016, p.7). Due to their beliefs which also had a cruical role in their alchemy, Turks buried their important or wealthy persons with golden clothes, however, they dissappeard because of tomb raiding (Çobanoğlu, 2012, p.984).

Said al-Endelüsi, author of Tabaktü'l-Umem, described the science of various tribes, and described Chinese and the Turks as the most vigilant and the most advanced of the non-science nations. He likened the rest to animals (al-Andalusia, 2014, p.51). Radloff, on the other hand, claimed that this tribe could not have been a blacksmith because they lived a nomadic (Bedouin) life hundreds of years later and he objected to the knowledge in Chinese sources (Barthold, 2015, p.26). However, even from the Byzantine sources, the wood carving of the Göktürks, even in the Huns period, was at an advanced level (Ögel (II), 2014, p.64). It is learned that they sat on iron chairs (Ligeti,

2011, p.88). According to Chinese sources, one of the oldest known words in the Hun language is iron (tieh-fa) and the other is sword (king-lu) (Kafesoğlu, 2015, p.216). Hsüen-chang stated in his travel book that Göktürk did not sit on tree chairs, used wicker or iron chairs, and added that they used iron in large amounts (İzgi, 2014, p.340-341). The Altai peoples were known as ingenious blacksmiths, a war industry that enabled them to establish superiority to the surrounding tribes (Candarlioglu, 2013, p.44). The environment also allowed settled cultures to exploit their iron ore (Kafesoğlu, 2015, p.215). Iron melting furnaces in northern Altai, iron furnaces and foundries in Ulan-ude have emerged based on archeological excavation and this information is supported by Chinese resources (Kafesoğlu, 2015, p.216; Ögel (II), 2014, p.144). Iron business workshops and bronze foundries emerged in the Ivolgi ruin, which was established during the Huns period and was found downstream of the Ivolgi River and Selenge (Klyashtorny & Sultanov, 2013, p.68). This place is thought to have been inhabited in the 2nd century BC (Ögel (II), 2014, p.52). Dealing with iron was a sacred pastime for them, and in the years that followed, the ancient Turks also became the arms manufacturer of the Juan-Juan (Ögel, 2014, p.74). Parker stated that perhaps they had developed it in the highly civilized Liang (Parker, 1987, p.130). Vasary said that by referring to the legends of the Gokturk origin, cave motifs here should be a reference to the mining and iron-rich countries because they were engaged in iron (Vasary, 2007, p.99). High quality iron was also found in the Tuyahta and Kuray kurgans (Ögel (II), 2014, p.168). Among the finds of Verhne-Udinsk, iron was also present, indicating that the Iron Age began in the northern parts of the Hun state (Ögel (II), 2014, p.52). The Turks and the Huns were the same tribe (CTS; 'Huns, the Turks do not want to be part of us'), no doubt De Guignes,

blacksmith in the Altai mountains after the settlement of a Hun hunter 'Turk' refers that he said that the name of the helmet shape and made of iron tools (De Guignes, 2018, pp.432-434).). Probably the Huns were known for being a magician tribe around them because they were proficient in blacksmithing (De Guignes, 2018, p.366). Ironworkers were the craftmans of the God (Eliade, 2000, p.105). According to the Yakut Turks, the blacksmith was a shaman or a magician which they came from the same nest (Ögel, 2014, p.76). On the contrary, Oceancian and American shamanism did not have a blacksmith or ironworking cults while ironworkers also had magical or spiritual roles by giving magic weapons of heroes (Eliade, 2000, p.90). They also produced armors (Eberhard, 1996, p.94). Nevertheless, they moved to look for wetlands and pastures (Chavannes, 2013, p.130-131). Although politically dependent on Turks, there were tribes that fed with horse milk and used copper and produced clay pots because their iron was low (De Guignes, 2018i p.79).

Dealing with iron within the Turkish Empire was not only a talent, an intellectual property, but also a necessity due to physical geography. Yakubi also stated that Turks have many genera and hometowns and defined Turks as non-crop Turks as *Ustan Turks*, and these were also among the Turks with less iron (Yörükan, 2013, p.141).

Mining, which is an extremely old occupation, started with the awareness that a green stone called malachite melted in the fire and the red metal flowing through which it was known as copper came from, and started to be processed by reducing it with wood fire but it was the first metal used because it was easily forged (Tez , 2010, p.27).

4.1 Craft in *Turks Lebensraum* Until the Hun Era

As can be seen from many of the above-mentioned studies in Central Asia, there was a life before the Turks or the Huns began to speak of themselves. Kuldara, which is the oldest place in Central Asia in the territory of Tajikistan, dates back 800-850.000 years ago (Vishnyatsky, 2002, p.486). Ögel said that it would be correct to take the Neolithic period as the starting point in terms of the finds in Turkish cultural history. The characteristics of the Jewel Kurgan in the Altai indicate that there were arrowheads and bone remains very similar to the culture of Afanesyevo, adding that a Neolithic area and digging tools were visible in a 20 cm lower layer. He stated that there was a hook, harpoon and knife-like plate retouched on the sides of the grave in Çudatskaya Mountain, which is considered to be older finds than the ones in Kuyum (Ögel, 2014 (II), p.11). Ögel, who drew attention to the findings of Yan Ulgan, stated that this was a culture with an ocher and red paint in the skeletons where the clay pots were not made, although it was newer than the old Chudatskaya culture of Afanesyevo, and then there was a dull culture age in the region until 1700 BC (Ögel, 2014 (II), p.13). Starting from 3000 BC, Ögel said that Afanasyevo culture had begun, and that the dead bodies painted in red were covered with soil or stones, and that the main date of this culture was dated to BC 2500-1700 (Ögel, 2014 (II), p.18-19). Although small knives, needles and ornaments made of bronze were seen beside the burials in this culture, the majority of the tools were made of stone (Topsakal, 2017, p.45). During this period, the use of mines began to be encountered in Kazakhstan, mining periods were entered in the Harezm area, while mortar hands and large mortar and copper articles were found in the remains of gypsum in Namazgahtepe in West Turkestan (Ögel, 2014 (II), p.20) -21). People of this culture,

because they did not know how to melt metals in their daily lives still used stone, but by beating the shape of the copper ore used in the region (Okladnikov, 2000, p.118). Taşağıl states that the Yang-sho culture emerged in Northern China as a result of the spread of this culture since 2000 BC (Taşağıl, 2014, p.47).

In the following period, the culture encountered was Andronovo culture, which included an area from the Urals to Yenisey, brought from about 2000 BC to 1300 BC, and the oldest finds were found in Southern Siberia (Topsakal, 2017, p.49). In this culture of the region, which also refers to the Bronze Age, shepherding and agriculture were carried out together and the use of bronze goods was determined from the third period of the development of the culture (Taşağıl, 2014, p.47-48). In this culture, simple irrigation channels and simple agriculture, as well as began to specialize in bronze, copper and fine ornamental tools were able to make (Topsakal, 2017, p.49). Ögel points out that there was a developed social life in the Altai in Andronovo. They started to cover their works made of copper and bronze with gold plates and the presence of areas such as Sari-Bulak identified with ceramics in the Altai is obvious. He said that the people living in all regions of this culture were not at the same level at the same time, for example Angara region had just entered the mining age in 2000 BC (Ögel, 2014 (II), p.22-28). Okladnikov pointed out that the development in this culture, especially in metallurgy, is important and the most commonly used is metal oxide deposited in the soil, and it was melted in primitive furnaces after being beaten with stone sledge hammers (Okladnikov, 2000, p.123).

Emel Esin pointed out that the communities living in the Central Asian region in thousands of BC were producing similar products and possessing items such as belts and

mirrors, and that they were extremely advanced especially in the production of weapons for mining. In addition, the people living close to China learned that the art of mining in the millennium BC, even developed in the style of advanced refinement, the Black Sea in the north of the Greek-Scythian craftsmen were benefiting from the techniques of mining and molding (Esin, 1978, p.3-6). The culture of Andronovo was first replaced in 1000 BC and later BC. Around 800, two different cultures, namely the Mayemir in the Altai, and the as Tagar culture in Minusinsk were shaped (Taşağıl, 2014, p.48). Karasuk people lived a semi-nomadic life at first and made weapons and hunting tools from bronze thanks to their knowledge of metallurgy (Topsakal, 2017, p.51). Okadnikov pointed out that this culture alone should not be considered as a whole (Okladnikov, 2000, p.126). Bone needles were also found in the graves of the Karasuk culture and pictures of tents with carts called 'kibitka' were also seen (Ögel, 2014 (II), p.30-31). In fact, the paintings are extremely important for chemistry applications which indicate that a color-giving property has been observed, even if made primarily by the development of dyes or by materials obtained naturally from soil. Esin said that it is understood that they lived in tree-shaped tree houses in the Tagar culture (Esin, 1978, p. 11). Gray-yellowish colors were found in pottery vessels (Bokovenko, 2002, p.522). In the following sections, the importance of this process will be elaborated with examples from a study on Chinese Blue and Chinese Purple. Esin also points out that, Mongoloid elements from the more eastern regions, played an active role in the formation of Karasuk culture (Esin, 1978, p.11). Karasuk metallurgy indicates a very large scale and large production and especially during this period, composite materials were obtained by mixing arsenic and tin to copper and they had a serious skill in this regard (Okadnikov, 2000, p.125).

Tagar culture, although more closed to the outside appeared in the bronze period (Topsakal, 2017, p.51). Esin remarked that Tagar culture bronze animal statues, gold or colored stones decorated with plates, human masks made of mines are identified in this culture (Esin, 1978, p.12-13). Tagar culture was evaluated by Okadnikov as a direct basis for the lifestyle and culture to be seen in Central Asia in the following years. In this period, it is pointed out that the invention of the curb, which allows horseback riding, was very important and that the peoples of this region can easily continue their lives on the steppe. Culture, with a high degree of dairy products, including lamb and lactic alcohol, neighbor hunters and fishermen was a culture that contained elements very different (Okadnikov, 2000, p.139). In Tagar culture, the size of bronze articles has been extremely small and has reached a high level. Because the latches, pipes and circles which are extremely technical necessities of this production process were determined and also gold plates were made, and also the findings of the precursors of mummification techniques were found in the tombs of Tagar culture (Bokovenko, 2002, p.518-522). It is observed that mining activities have been carried out in the lands in the north of China since ancient times. It is explained in the previous section that chemistry is the driving force behind the craft and industry of ancient times. When it is considered as a kind of chemical production of the ages, it can be thought that the peoples living in the region have developed tools for survival since ancient times.

4.2. Craft Hun Period

Hun State is the first state established by Turks in history (Taşağıl, 2014, p.51; Baykuzu, 2012, p.22), at least the state established by members of the Tu-ku (Turkish) family or clan (Ahmetbeyoğlu, 2017, p.91) It is important in Turkish history because it

was the first time to gather Asian tribes under a flag. The formation of the Hun State initiated a process that would contribute to the establishment of cultural unity in Central Asia (Ögel, 2014 (II), p.43). Although the name of Hun can be taken up to 2525 BC in Chinese sources, it was mainly written in a Sogdian letter dated 31.3 AD (Tasagil, 2014, p.51). Archaeological finds related to the Huns gives ideas about their craft life. Among the finds known as the Ilmovaya-Podi finds and included in the Huns 'Northern Cultural Boundary' area were wood artifacts, Huns made of bone as well as Chinese silk springs, as well as arrows with iron tips, Chinese chopsticks and Chinese mirrors (Ögel, 2014(II), p. 50). In the Hun necropolis, known as the city of Ivolgi, there are iron and bronze foundries, but cast iron spurs, foundry tools, iron sickles and various agricultural tools (Klyaştornıy, 2018 p, 43). Evaluating the iron objects seized in the Verhne-Udinsk kurgan, Ögel said that the pure copper age is now definitely over in the north of the Hun State and that the iron age has begun (Ögel, 2014 (II), p.52).

In the Ordos region, which is accepted as the Chinese border culture environment, there are many bronze artifacts which are thought to belong to the Huns and are different from the Chinese artifacts. Luan-p'ing, located in the north-east of Beijing, yielded bone arrowheads and bronze trappings, and only one item made of iron, which Ögel thought is a Mongolian or Turkish-Mongolian mixture (Ögel, 2014 (II)) , pp. 54-55).

The first examples of the kurgans, which will be explained below, which form the basis of Hun grave culture, date back to the Neolithic period (Baykuzu, 2012, p.193). Around the central culture, Noyun-Ula is an area ruled by Mongolian princes under the control of the Hun state, where coffins with gold plates and glue traces were found, traces of lacquer and paint were found on the inner parts of the princes and brought from their

neighbors, including wood and bronze pots (Ögel, 2014, p.57-60). Furthermore, many bronze and a few iron tools were found here, Baykuzu believes that valuable items were stolen by robbers (Baykuzu, 2012, p.206).

Within the scope of the Altai Culture Environment, red and green cloths with gold inlaid buttons and ornaments and a curved Turkish sword were found in Katanda (Ögel, 2014 (II), p.60-61). In particular, mushy corpses, small tables made of wood, pots, mortar hands, household items and horse harness ornaments, such as advanced woodwork, long dress known as golden robes, felt socks and boots decorated with metallic plates, whip, bronze or wood gems made of winding leather glazes, mummies were opened in the shape of 'T' and sewn back (Ögel, 2014 (II), p.62-67). In these kurgans, a large number of wood and timber finds, as well as bronze, silk and leather remains were found and the most important find of which is Pazyryk Carpet yellow with red floral embroidery on the ground (Baykuzu, 2012, p.195-201).

Finds from Shibe included lacquered Chinese vessels, mummified corpses, horses and harnesses, carved ornaments made of wood, underlays, bone diggings and iron plates with black paint marks (Ögel, 2014 (II), p.69). In this fiction, it was found in varnished vessels that provide dating to the years between 86-48 BC (Baykuzu, 2012, p.202). As mentioned above, the use of black paint is important for chemical applications. Ash and coal remains found in Berel finds, especially in bronze age, but with many tools made of iron (Ögel, 2014 (II), p.73) Sibe finding may be related to the black dye found in the stake, but also to the burning process for the enrichment of iron to carbon.

It is important to have an idea about the content of the paint and to have an idea about the techniques developed by the people who used it. The colors known as Chinese Blue and Purple were produced in China in different techniques than in Egypt because there were no basic sources used by Egypt. The formula of Egyptian blue was defined as $CaCuSi_4O_{10}$ and was obtained by heating sand (quartz, SiO_2, limestone, $CaCO_3$) and copper minerals (azurite, malachite or sulphide) to high temperatures such as 900 ^{0}C. The main source of blue color was lazuli. In China where this was not the case, a similar formula was used and the absence of calcium was filled with barium. Unlike Chinese Blue, in ancient times they were trying to fill this demand with cobalt oxide and indigo blue, and azurite which gradually turned into more stable green malachite in the open air (China Blue, $BaCuSi_4O_{10}$, Chinese Purple, $BaCuSi_2O_6$, first in South Africa, Kalahiri Manganez where it was found as a natural mineral in its area but there is no purple) (Berke & Wiedemann, 2000, p.95-96).

Malachite was the first mineral that people started mining, but it also had widespread use in Egypt as an eye dye, and after observing that it melted in fire, it started to use copper (Tez, 2010, p.31). In his book ‘Precious Stones and Metals’, Biruni told that the Arabs learnt Lapis lazuli came from Armenia and says that it was known as *erminacone* in Roman language and gives a unique color from other stones. He said that Malachite is a dark green mine known as *tutiya* in India from which copper is obtained when it is melted, and also used by chemists (Biruni, 2017, p.247-249). The Chinese obtained the minerals required for the BaCu-silicate pigment from the Gansu region (Berke & Wiedemann, 2000, p.103). Necessary information about the material structure of the material can be obtained by SEM and EDX studies. In their comments, Berke and

Weidemann described Chinese Blue and Purple as pigments that chemists would have difficulty in preparing even today, but they stated that it was a long-term and large-scale empirical discovery, not because chemists were able to develop and write complex chemistry formulas as they do today (Berke & Wiedemann, 2000, p. 97). Turk preferd t bury their corps with red ochre if the corp was not enough wealt to provide enough gold for golden clothes (Çobanoğlu, 2012, p.984).

In the process of obtaining steel from iron, the outer surface of the iron had to be contacted with coal in the process of coating with a thin carbon layer, and more durable steel was obtained by this carbonization process of iron (Tez, 2010, p.31). Many silver artifacts were also found here (Ögel, 2014 (II), p.73). Tuyahdi kurgan found iron sword fragments and saddles decorated with leather and tree bark (Baykuzu, 2012, p.202).

Ögel stated that the Turkish cultural characteristics started to be seen in Kazakhstan at the end of the Hun era and that the findings were bone armor plates and arrowheads, and claimed that the beginning of the iron age was due to the Altai region (Ögel, 2014 (II), p.77-79). However, a famous man in gold dress dating from the 5th-4th centuries BC was found from the Esik Kurgan in Kazakhstan and silver bowls were also found (Baykuzu, 2012, p.206-208).

Ögel also mentioned the Yenisey-Kyrgyz environment and stated that there was a plaster of 60 cm thick mud on the grave in Oğlaktı and that there was a plaster mask and a skillful mummification process on the face of the skeletons and that the metal items were not equivalent (Ögel, 2014 (II), s) .87).

Baykuzu attracts attention to the kurgans in China, Hsi-kou P'an cemetery pottery pot, cube pot and gold accessories, plates, bronze horse, arrowheads and rings with materials such as gold, silver, jade, stone and glass pointed out that there are objects (Baykuzu, 2012, p.211). In another detailed mentioned Tao-tun-tzu cemetery, sea shells, bronze rattle, bronze pipe, iron-bronze alloy knife, iron ax, crochet, curved knife and various ornaments were found (Baykuzu, 2012, p.213). The Li Chia T'ao-tzu cemetery yielded bronze rings, bone bows and seashells, and, according to Baykuzu, this cemetery is probably the Hun-yeh and Hsiu-t Boyu who surrendered to the Chinese emperor after an internal conflict in 121 BC (Baykuzu, 2012, p.214). As a result of the other excavations, various iron, gold, silver, bronze and wooden articles were found and a black painted ceramic hand-made pot was found in the East Miao Valley cemetery (Baykuzu, 2012, p.215-222). As it can be seen, both the ware made of mines and some painted materials indicate the existence of a chemical craft during the Hun period.

In the Hun period, an advanced bronze age was passed and it is understood that, apart from the sources where specialization in iron smelting and bronze casting was provided, for example, the bodies of the members of the ruler family could be covered with thin gold layer (Vural, 2016, p.54-58).

4.3. Craft in Gokturk Era

Gokturk had the title of being the first Turkish state established with the Turk name and Taşağıl identified Göktürk as model for other Turkish states established after them (Taşağıl, 2014, s.123-124). Described by Grousset as the descendants of the Huns, the homeland of the Göktürk was the Altai region where they were blacksmiths (Grousset, 2017, pp. 109-110). The Chinese legends defined them as a branch of the

Hunsname known in history. Referring to the Turkish epics, Sodnom claimed that the Ashina family did not constitute an ethnic center, but that they established and ran a blacksmith center of different elements that made blacksmiths from other races and regions (Sodnom, 2018, p.117-118).

This last example is a critical approach to whether they were a direct ethnic Turkish element, since made a strong reference to their blacksmithing, craftsmanship, and also suggests that cultural interaction in the steppe was at a very high level. It is fair to argue that the meaning of the Turkish name by Esin was related to the 'tolga' shape of the region settled for making this blacksmithing (Esin, 1978, p.85-89).

Although there is no earthenware pot remaining from the Altai, pots made of trees were found. Earthenwares were obtained from Orhon and Tula. However, mugs with silver handles and silver handles, which are considered by Ögel as the most important works in Turkish cultural history, were found to bear similarities in Kopen, which lies in the land of Katanda, Kuray, Tuyahta and Kyrgyz (Ögel, 2014 (II) p.159). According to Vural, the mining process was very developed during the Gokturk era and it shows that they sell their products to their neighbors as an example (Vural, 2016, p.147-148). A mirror with similarities with Chinese examples was also found in the Kuray (Ögel, 2014 (II), p.161). It is stated by Ögel that the oldest sword in the Altai Mountains comes from the Kudırge kurgan. He stated that this was a complete prototype of Turkish swords, but he did not provide information about the material (Ögel, 2014 (II), p.163). Iron finds were found in the excavations carried out in the south of Ms Gol Adag and Ulaan Üzüür Mountain, and they were found to be suitable for the life they live in summer and winter, while they lived in raw mud brick houses in winter or in stone tents in summer (Sodnom,

2018, p.111-113). Excavations include horse saddles, stirrups and gems. However, there was no metallurgical information about the material here (Ögel, 2014, p.166-167). Göktürk, like the Huns, were skilled in the application of the ‘‘eyebrow technique’’ to gold and other metals and adorned the precious stones (Vural, 2016, p.57). In Salınçak and Onugug mountains, there are sources of soft and hard steels, but high quality steel grades were found in Tuyahta and Kuray kurgan. Russian traders are also said to prefer the knives made by Altai blacksmiths who are especially skilled in welding (Ögel, 2014 (II), p.168). According to the Hsüen- ch’ang Travelogue (629-645), gold, silver, copper, iron and lead were obtained from the mountains around Kao-ch’ang (İzgi, 2014, p.341). Hsüen-chang stated in his travel book that Göktürk did not sit on wooden chairs and used wicker or iron chairs. He added that they use iron in abundance (İzgi, 2014, p.340-341). Archaeological studies have also confirmed that steel is produced in the Sayan and Altai mountains and that gold, silver, copper and iron are present in the south of Tanrı Mountains (Vural, 2016, p.54). Recurrent superheating of iron in wood fire was also used for steel production (Tez, 2010, p.32). At the same time, the above mentioned Turkish mastery of the woodwork, but also the fact that there are many examples of the use of the tree in the finds, think that the Turks may have combined these two with a long-term observation.

In addition, the information provided by the Sino-Turkish war, the Ch'ang-an Turks under the command of Elig and T'u-li Khan due to heavy rainfall due to the heavy use of glue in their springs to attack the enemy has stopped attacking the enemy (Togan & Kara & Baysal) , 2017, p.125). It is a known method to obtain glue from the boiling of the waste materials produced during leather processing in old times (Tez, 2010, p.41).

4.4. Consideration of Inner Asian Ironworking Until Uighur Period

Gelegrodj et al. in Mongolia, the Turks also separated and examined smithery in three separate periods in the homeland of the Turks and while doing this, the Hun period (BC 3rd to AD 1st), the Turkish period (AD 6th to 10th), Hitay (10 and 12) and finally the Mongol Empire and 15th century, and stated that the role of nomadic peoples in northern China has not been adequately elucidated, but has played a role in the transfer and development of technology (Gelegdorj, Chuang, Gordon & Park, 2006, p.1187). The regions where the samples are taken are shown in bold capital letters and are identified as Hun for X, Turkish for T, Hitay for K (Khitay) and M for Mongolian (Gelegdorj et al., 2007, p.1188). (See figure 1)

Figure 1 Map of Mongolia showing the places where samples were taken (Gelegdorj et al., 2007, p.1188)

Optical microscope, SEM and EDS examinations of the obtained samples were made and it was understood from the images and chemical distributions that the Fe-C alloy ratios were 3.5-4.2% less than that of the previous Hitay and Mongolian periods in terms of the content of the products of the Hun and Turkish period, whereas the newer Fe-C alloy ratios were 3.5-4.2%. It is observed that silicon, sulfur and phosphorus have

been observed in the range of 2-2.5 to contain carbon and this is a result of higher temperatures being reached during the production of new samples, in which the coal mineral is the result of the replacement of the wood-derived side of the coal (Gelegdorj et al., 2007, pp.1193-1195).

In the study carried out in order to understand the technology of blacksmithing, covering the Hun State period and the 3rd and 2nd century BC, it was concluded that a unique and unique iron production technology was developed here from China (Park, Gelegdorj & Chimiddroj, 2010, p.2689). The places where the samples are taken in today's Mongolia geography are as follows (See figure 2),

Figure 2 Map of Mongolia showing the places where samples were taken (Park et al., 2010, p.2690)

EDS (energy dispersive spectrometer) supported SEM (scanning electron microscope) analysis on samples and chemical distribution and microstructure were determined with the help of optical microscope (Park et al., 2010, p.2692). In the samples, except for the two made with cast iron technology, low carbon ions were detected in the structure, but the carbon content did not cause the expected carbon effect

on the main structure, it was found that it was generally on the surface and it was evaluated that there was a repetitive carburization process (Park et al., 2010, p. 2695). This method of making steel was known since 1000 BC (Tez, 2010, p.31). It is known that this method, which is very profitable for small scale and small populations in general, has been applied in the steppes in the north of China and in the west steppes since 8 BC (Park et al., 2010, p.2696). When the history of iron is examined, it is seen that Europe applies beater and China applies cast iron (Tez, 2010, p.31).

Park et al. as a result of their work "bloomery" smelting and carburization steel production methods well known by the Huns and cast iron technique unless there was a sudden increase in demand for cast iron has concluded that there will be a serious impact. However, they stated that they were able to produce a small number of cast iron and also used bronzes of cast iron and they were in the early stages of the cast iron industry. Considering the om bloomery ’iron production areas identified in the Baykal region, they found that the Huns continued this industry and stated that the cast iron products obtained in these regions may be of Chinese origin (Park et al., 2010, p.2696). ‘Bloomery’ method is also known as direct melting method, while cast iron method is known as indirect method (Liu, Chen, Mei, Jia & Shi, 2014, p.56). The situation seen here, in proportion to its population, adopts the appropriate production method of a tribe and Khitay during the period when it was seen that cast iron comes to the fore (Park et al., 2010, p.2695), it can be considered that the conditions continue to be appropriate. It may be considered that the Turks may have recognized the material produced in this way through trade or war, but not because it was not needed to be used. Below there is a diagram of the furnace and process where bloomery irons are produced (See figure 3).

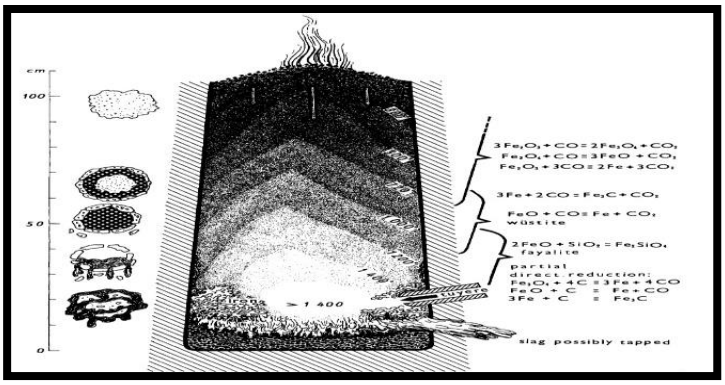

Figure 3 A schematic representation of a bloomery furnace in operation

https://www.haraldthesmith.com/wp-content/uploads/2017/05/FurnaceSchematic_Pleiner2000.jpg

The results of the analysis of the finds in the Yan region, which remained in northern China during the period of the Warring States and the Han Dynasty, were considered to be the center of innovation, suggesting that the material was used in the Tang and Song dynasties in the following years. It was concluded that the cast iron or cast iron steels were used in editions, and the weapons were made of annealed steel in the furnace, while the iron cast was used for agricultural production, while the bloomery technique continued to compete in the Han era for a long time in the region (Liu, Chen, Mei, Jia & amp; Shi, 2014, p. 62).

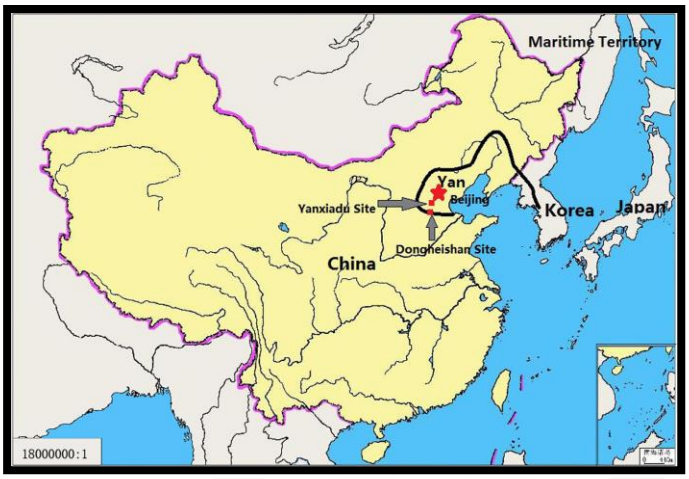

Figure 4 Yan Region and excavation areas where samples were taken (Liu et al., 2014, p.54)

Simokatta, one of the Byzantine ambassadors, clearly stated that the Turks showed extraordinary respect for fire (Grousset, 2017, p.113). As explained above, the production of iron has the importance of fire since the oldest periods. Contrary to the ancient Greek civilization, the so-called ‘mechanical arts uğraş did not bear any negative social stamp and shame in society. The punishment of Prometheus, who stole fire from the gods, that is, the representative of the technique for the ancient Greeks, showed the fear of the technique (Bumin, 2016, p.23). It is seen that the craft activities in the Old Turks are much more developed. In particular, the main method used by Bulgarian smiths was to incorporate carbon into the metal through heat treatment, where it was possible to melt ores containing various chemicals and obtain high-quality iron between the 9th and 11th centuries, where metals such as copper, lead, tin, mercury, silver, gold in particular, it is known that the ironworkers have a deep knowledge to master them in different materials (Davletşin, 2013, p.359). Wang Yen-te, who came to the Uighur lands of the Turkish country between 981 and 984, stated that the Turks produced ammonia

from the mountains of smoke rising from the north of the Beşbalık region, while doing this, the masters of this work entered this area with leather shoes and not with six wooden shoes. He also stated that there is a cave that produces blue mud and that this material, which is turned into sandstone after its exit, is used for leather tanning (İzgi, 2014, p.338-341). As it can be understood from this information, in later years, Uighurs who lived closer to China in similar periods with the Bulgarians were also involved in a process which was directly related to chemistry and the subject of their interest was probably the science of ancient times such as trial and error and observation. They were developed as Ivolga, Baga Gazaryn Chuluu and EDS analyzes and optical microscopy studies on samples obtained from Bayaan Bulag, Mangasyn Khuree and Sairyn Balgas on the northern border of the Chinese sediment were found to have a certain amount of arsenic, which was observed for the pre-Hun and Hun period. In addition, it was found that the introduction of iron instead of copper provides a great advantage in mass production (Park, Honeychurch & Chunag, 2016, p. 67). 483). However, studies on weapons in this Hun-China border region have identified significant chemical and mineralogical structure differences from those built in the central regions of China (Park et al., 2016, p.456).

RESULT

History of science and philosophy of science have not been considered as separate areas for a long time as shown in the study. Nowadays, although there is strong acceptance that modern science is the result of a process called the Science Revolution, there are also antagonists, such as Patrica Fara. It is not possible to draw a strict boundary between science and technology. While science has often been influenced by technical developments as seen above, the first of the intelligent views and experimental views put forward for the understanding of nature, especially during the Science Revolution, is based on the intellectual practices of the past, while the experimental method is often based on daily practical needs as well as magic / mysticism. While Greek science is an intellectual endeavor, it is seen that technique or observation of nature for mystical purposes are found especially in places such as Egypt, Mesopotamia and China. Although not seen in the early years, especially in the 19th century, the conflict of science and religion began to settle with a number of ideas from mathematics / geometry about what should be considered science and not counted. In the following period, especially the scientific developments that hit the determinist views and the subsequent destruction of the absolute accuracy of the Euclidean geometry, in which other geometries were created within other axioms, revived the questions about what science is again. Thomas Khun said that every revolution in science would destroy all the righteous ones in the field and all that structure beforehand with reverse propaganda for its own validity. To justify the validity of the paradigm theory, for example chemistry, it blamed itself for being totally fake and tried to sever all ties with it. However, chemistry has benefited from Alchemy as a tool for many years, and has benefited from its extensive

and long-standing metallurgical literature. Above, especially in the period before the Chemical Revolution, the information obtained through the use of alchemy is given examples. Science, in fact, from the earliest times, people's sense of curiosity towards nature, as well as survive, the problems they face to produce solutions to the activities that have been carried out in order to continue to exist.

While Chinese chemists produced Chinese Blue and Purple, perhaps they did not give a generic chemical formula to the following generations or explain the atomic structure of the minerals and minerals they used, hence according to Berke and Wiedemann defined this as an empirical discovery based on many years experiment. Khun argued that the scientific or technical work done in the past as a result of people thinking with different paradigms is now considered totally unscientific. Although it seems difficult for a people struggling to survive in difficult conditions in nature, it seem to be difficult to make progress in the intellectual direction of science, however it is not possible to show any technical developments, especially in ancient times, it has been observed that farmers could not deal with the tribes and nomadic invaders' arms techniques. Nomadic or shepherds actually lived together with established agricultural societies, and wars were usually mutual.

As explained above, especially during the 19th century, when History gained a scientific meaning, Social Sciences had a deterministic reading from the Natural Sciences. This was based on the belief that the colonial or defeated peoples of that century were in that situation as a result of their backwardness from their past, or that they had not developed as a result of their failure to follow the same line with the West. As seen in the Radloff example above, even from time to time, even the sources could

not be correct by looking at the state of society at that time, or, as the Dutch did, it could be based on the assumption that it would belong to other, more advanced, peoples of Europeans who would be considered ancestors, but from time to time could even turn to their own past. The fact that they are regarded as non-rule communities that have led their lives indiscriminately has created a prejudiced viewpoint towards the Turks. The reason behind the definition of barbarian is the idea that the Turks lived in nomadic life. The life of these nomadic communities that lived a simple tribal life was not worth investigating. It was not thought that such a people could have any share in any development considered the product of civilization.

As a result of the studies carried out today, it is seen that the Turks know mining, confirming the sources. It is seen that mining is an important driving force especially under the developments and changes in chemistry and science examined above. Most of the Turks are living in nomadic settlements, but as the findings point out, they may prefer settled life and agriculture, or even settled before becoming nomadic. First of all, it has been determined that the Turks as a whole do not consist of all the same behaviors.

Inventions in radioactivity in the second half of the 20^{th} century and two successive Nobel Prize-winning inventions in 1960 and 1961, Williard F. Libby found the natural radioactive isotope of carbon ^{14}C. Then it began to be used up to 40000 years for the age determination of organic materials. The following year, in 1961, Calvin pointed to the chemical description of the metabolic pathway carbon follows during photosynthesis. Approximately 20 years later, the isotope analysis method was developed by the combination of these two inventions and serious studies were started on the nutrition regimes of ancient times. As explained above, some analyzes have suggested

that even people living in the same area, in the same place may have different diets, or in some cases it is thought that strangers live among them. These studies have resulted in the conclusion that there is nutrition based on agricultural production in many regions, that fishery is carried out, and sometimes there are important results such as differences in fish preferences of the people living in the same cultural region. Although these studies are seen as cooperation between history and chemistry, when they are considered as the main application areas of chemistry, they do not seem to be the subject of chemistry. In fact, the experts here do not help the science of chemistry directly based on the subjects of chemistry as in the old times, but they use chemistry to illuminate a completely different field by using intense knowledge of chemistry.

Finally, in the geography dominated by Turks, the results of the metallurgical analyzes in North China showed that the Turks produced iron by similar methods during the Hun and Göktürk periods. It was observed that this method, known as the 'Bloomery' method, was replaced by the cast iron method in the Mongol era, which was dominated in the region in later years, but even during these periods, the differences in the structure of the arms of the Chinese border regions compared to the central regions were discussed.

As a result, it should be considered that the period examined in the studies of the history of science should be understood well, taking into consideration the precision of the structure of science. Turks have been on the stage of history in the north of China since ancient times, played a decisive role in the politics of Central Asia and China and maintained their continuity in history for many years as a tribe, adapted to the needs of their geography, and continued their lives by meeting their needs. Certainly, the Turks,

like the Chinese paint manufacturers, did not know the chemistry of today or worked according to its working principles. However, if Chemistry is evaluated with the qualifications gained after its revolution, it will not only be for the Turks but for all of the tribes. It should be kept in mind that the works of these periods, which are the direct subject of chemistry, are essentially the field of craft or art.

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