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Source, origin and formation of tektites with respect to their physical features and chemical compositions

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Abstract

A suite of 17 samples of tektites from Czechoslovakia, 2 samples of tektites from China, 2 samples of tektites from Tibet and 1 sample from Philippine were investigated to know their physical features, oxide and elemental composition and from these studies to understand and know their source, origin and formation through analysis by XRF. The analysis carried out through XRF showed that the major component is SiO_2 in all the four types of tektites and the average composition of SiO_2 in all the four tektites is around 74.37, the second component is Al_2O_3 which is 12.89 with other major oxides in smaller percentage and the rest in negligible compositions. For comparison Igneous rocks (i.e., volcanic and plutonic) were also investigated. From the studies carried out through this paper, it is concluded that the source, origin and formation of tektites is related to a comet, close encounter with earth in the remote past. The present paper attempts to understand the source, origin and formations of tektites with respect to their physical features and chemical composition along with earth volcanic rocks and plutonic rocks and to put on records the work carried out. This work is of preliminary investigation and on prima facial basis.

Keywords: Tektites, grooves feature, black color, particular shapes and size, earth rocks, meteorite impact craters.

Introduction

Tektites are black colored rocks with grooves feature on their surface totally different from earth rocks and meteorites. Their shapes and sizes vary, they are named where they are found e.g., Philippinites, Indochinites, Australites, Czechoslovakian tektites, Tibetan tektites etc. Each one has a characteristic feature, their source and origin though unknown; Some researchers are of the opinion that their source is through extra terrestrial, while others opinion is that they are of earth origin, formed due to meteorite impact. There are many different kinds of tektites found all over the world. They are segregated in large numbers at certain places, known as strewn field. But wherever they were found, no occurrence of impact crater by a meteorite has been found. Hence today its source and origin and formation are still unknown. Reynolds mentioned that F. E. Seuss, an Austrian geologist was the first person to use the term tektite in 1990. It comes from Greek word 'tektos', which means melted or molten in Greek language[1].

Scope of work: To understand the source, origin and formation of tektites with respect to their physical characteristic features and chemical composition with respect to earth volcanic and plutonic rocks and meteorite impact craters.

Some of the works carried on tektites by researchers: Son and Koeberl studied tektites and stated that Chemical variations within each of the tektite fragments exist, but do not show any systematic trends for both major and trace elements[2]. Yung et al. carried out Geochemical studies of tektites from East Asia and stated that the chemical of tektites in this study indicate that they were derived from similar target rocks which may be related to post-Archean Upper Crustal materials[3]. Hermann stated that the Spratlies Archipelago structure with its giant 275km size, recent appearance, and its exploding in the middle of a collapsing continental slope of Sunda Land is the ideal source formation for the AA tektites[4]. Paisarnsombat et al. studied tektites and concluded that the result is in consistent with a black color of the tektite. It indicates that cause of color in tektites is related to Fe-content and can be explained by the energy band[5]. Benilde et al. studied meteorites and tektites and stated that the observed hyperfine parameters and higher Fe^{3}/Fe^{2+} ratios in Muong Nong than in other tektites are consistent with the conditions under which Muong Nong tektites are assumed to be formed[6].

Observation: The color of all the four types of tektites i.e., China tektites (Figure-1,2), Czechoslovakian tektites (Figure 3-13,15-17), the image in Figure-13, Czech tektite showing cratering feature on its surface in the middle and in Figure-14 image of a Bennu asteroid showing similar feature, Tibetan tektites (Figure-18,19) and Philippinite tektite (Figure-20), are found to be typical dark black in color. On all the tektite surface grooves feature is observed and on some tektites cratering feature is observed, no matter, where they were found. On some Czech tektites, a small patch of glaze is seen (Figure-13).

Most of the tektites one side is covered with grooves feature and the other side is smooth surface (Figure 3-13). The tektites under study are of different shapes and sizes (Table-1). Detail observation under student's microscope of 20X and photographed by mobile camera having 64 pixel, shows that bubble type of feature is seen, which indicates that, the tektites under study were subjected to high heat phenomenal event of unknown nature i.e., they were heated and then melted (Figure 21-24). Figure-23 and 24 shows that tektites observed under student microscope of 20X reveals a dark black component of unknown nature. The grooves feature is a peculiar feature seen on tektite surface, no earth rocks (Figure 25-29) has this kind of feature on their surface.

Methodology

The tektites made available for study purpose were of 4 types, China tektites 2 samples, Czechoslovakian tektites 17 samples, Tibetan tektites 2 samples and Philippinite tektite 1 sample. Their physical parameters like weight and volume were taken and noted down, from this density were calculated. Their physical features like color, dimensions, surface features, etc., were examined and noted down, finally the samples were sent for XRF analysis. Along with tektites, earth volcanic rocks and plutonic rocks has been considered for comparison.

Experiments: The weights of the samples under study were taken on a standard balance dully calibrated, the weights were noted down, their volume were taken by water displacement method by using a measuring cylinder of borosilicate make and finally density was calculated using the formula density = mass/ volume g/cc. (Table-1), dimensions of each sample were taken by foot rulers and noted down (Table-1). After carrying out physical parameters, the samples were sent for XRF analysis (Table-2,3).

Experimental results: From the physical parameters in Table-1, it is observed that the average density of the samples of Czech tektites under study is found to be 2.2258g/cc (Table-1), the density of China tektites are found to be 2.3907g/cc and 2.3980g/cc (Table-1), the density of Tibetan tektite is found to be 2.27415g/cc and 2.21845g/cc. Density of Philippinite tektite is found to be 2.3275g/cc (Table-1). The average density is found to be 2.25g/cc. The sizes, shapes and dimensions are all given in Table-1. From the results by XRF analysis, (Table-2, 3), it is found that SiO_2 is the major component with 75% (avg.) in Czech tektites, in China tektites, it is 74.150% (avg), in Tibetan tektites, it is 74.25% (avg) and in Philippinite tektite SiO_2 is 74.100%, besides SiO_2 as major component, other major oxides such as Al_2O_3, Fe_2O_3, CaO, K_2O and MgO are also present, including other oxides in minor compositions.

Results and discussions

The observation of Czech tektites (17 Nos) under study shows smooth surface, while on the other side grooves of different nature (shapes and sizes) are observed, Figure-3 to Figure-16. Their shapes are of irregular, oval or egg shaped, elongated in nature, sizes are also different. The density of Czech tektites ranges from 1.84g/cc to 2.71g/cc. From Table-1, average density is about 2.2258g/cc. Out of 17 samples under study of Czech tektites observed, 12 samples show a glaze (smooth and glossy) like feature on a small part of their surface (samples Nos. 1, 6, 8, 9, 10, 11, 12, 13, 14, 16), large part of the sample No. 7 has a glaze like feature whereas sample No. 15 shows a small tinge of a glaze. All the samples under study show typical dark black color, (Table-1).

China tektites (2 Nos) under study show grooves on most part (Figure-1,2). Smoothness is seen on small parts only; both the samples are light black in nature. Density of China tektites is 2.3907g/cc and 2.3980g/cc, and the average density is 2.39g/cc, the shapes are somewhat oval, similar to an egg shaped (Table-1). From the detail observation of China tektites, inner part of grooves shows a glaze (smooth and glossy) like feature, which means if one slice the China tektite or a small part is sliced, inner part will probably show a glaze as observed on some Czech tektites, (not shown in the figure). It is possible that all the tektites found on earth may show similar feature. The inner part may show a glaze, this feature is probably not observed on meteorites fallen on earth or any earth rocks. The origin of which points to an unknown source. It is not understood how these features like glaze (smooth and glossy) has been attained on some parts of tektite surface, (Figure-1,2), (Table-1).

Similarly Tibetan tektites (2 Nos) under study show grooves feature on most part and smoothness is seen on some parts (Figure-18,19). The color of the Tibetan tektites is dark black. The density of Tibetan tektites are 2.27415g/cc and 2.21845 g/cc. and the average density is 2.2463g/cc., shape is somewhat elongated (Figure-18,19), (Table-1). Philippinite tektite (1 No.) under study shows grooves feature on its surface. The color is dark black. Tibetan tektites and Philippinite tektite seems to be similar in color. The density of Philippinite tektite is 2.3275g/cc. The shape is somewhat oval (Table-1, Figure-20). The surface feature is similar to Tibetan tektite, but different from Czech tektites and China tektites.

The grooves feature on tektites surface, is it a natural design pattern? Is unknown. All the tektites found on earth are dark black in color and show grooves feature of different shapes and sizes, is it a coincidence? Is unknown. All the four types of tektites are brittle in nature, homogeneous mass, opaque, dull or earthy luster, formed from an unknown source composition and of unknown nature (Table-1). The density of all the tektites found on earth irrespective of their findings at different places are found to be similar, is it a coincidence? Is unknown.

In Czech tektites, the major component is SiO_2 which is 75%. Chemical composition of Czech tektites is shown in Table-3. In China tektites, the major component is SiO_2 which is 74.15%. Na_2O is absent in both samples.

Chemical composition of China tektites is shown in Table-2. In Tibetan tektites, the major component is SiO_2 with 74.25% (avg.). Detail chemical composition of Tibetan tektites is given in Table-2. In Philippinite tektite major component is SiO_2, percentage being 74.100. Detail chemical composition of Philippinite tektite is given in Table-2. Conclusion from Table-5, shows that of all the four types of tektites average composition of SiO_2 is 74.37 and the second highest is Al_2O_3, average of which is 12.89, which are higher than earth volcanic rocks.

If one observes the Table-2,3 it is seen that the oxides SiO_2, Al_2O_3, Fe_2O_3, K_2O, CaO, MgO, TiO_2, MnO, ZrO_2 and BaO are present in nearly equal proportion in all the tektites, irrespective of their findings at different locations, it is not a coincidence, which indicates that the material from which the tektites were formed are of the same nature, irrespective of their fall at different locations around the world. From the observation and the images of Tibetan tektites and Philippinite tektite, they show similarity in color and grooves feature. From the observation of each set of tektites, it is seen that they were formed totally at different environments. Hence, although the color and the grooves feature are prominent, the grooves feature show different pattern or forms for each set. Individual samples also show different forms from each other of the same strewn field.

It is postulated that in some unknown era in remote past, a comet coming from Interstellar space, blazing towards the solar system on its path around the sun, happened to approach earth. In its closest encounter, i.e., two celestial spheres coming in contact with each other, tremendous flash of lightning occurred between the two bodies, due to which high heat phenomena evolved and the cometic material was heated and melted. This process of heating and melting of cometic material took place due to lack of oxygen (i.e., incomplete burning process). The melted component of cometic nature being in molten state was pulled by gravitational force of the earth, remained as it is, while entering the earth's thinner layer of atmosphere, when came in contact with earth's thicker layer of atmosphere immediately cooled, solidified into a hard solid mass and fell on the surface, retaining their physical feature i.e., typical black color and grooves feature. From thence onwards till their find laid on the earth surface. Due to this event the earth was disturbed and was totally in chaos.

The formation of tektite rock is considered as a cometic material mainly containing silicates, which had undergone heat and cold treatment continuously, in heating condition in vacuum, in absence of oxygen, material burnt/heated (deteriorates or reproduce) carbon monoxide, soot coke etc., which is found to be coated on the surface of the cometic material i.e., incomplete combustion (lack of oxygen) in over indefinite period. These characteristic features were further carried in earth's environment, when these material fallen on earth surface.

In short, the whole process of tektite formation can be explained briefly as follows: Talking about the formation of tektites and their physical features, the color of the tektites is typically dark black. The color is adhesive in nature. It cannot be removed, while handling of these stones, one's hand or instrument cannot turn into black. It cannot attribute, dispose or defuse its color to the surrounding things. The black color of tektite is typical like tar or coke.

It appears as typical black color and having average density of 2.25g/cc. It seems that these stones were formed in the environment of high energy and then it became whatever it appears. This is the process of incomplete combustion in the vacuum at indefinite period of time scale. It is therefore a product of incomplete burning, i.e., combustion in lack of oxygen or sparingly in presence of oxygen, which is similar to process of artificial coke formation. Tektite rock had gone under all the above mentioned process in space, that's why it appears typical black in color. In other words it can be said that the burning process was not fully complete, so silicate rock underwent incomplete burning and formed what is known as tektite rock, it appears as black because this is incomplete silicate burning process. Tektite means "Intermediate state (i.e. incomplete burning process) of silicates and carbon compounds".

It is known that comets carry different debris of Interstellar space (Long period comets), and Interplanetary debris (short period comets), deposit or leave on their path while crossing the orbit of each planet on its journey around the sun. Some mineral debris remains in certain places in space in indefinite time and had gone under burning process, but that burning process happened without oxygen. So tektite formation is one of the rocks, which is the output of incomplete burning process like soot or coke. It is incomplete combustion of carbon i.e., similar to formation of soot, carbon monoxide etc., the cometic material is spread over throughout the solar system.

The variety of environments like tremendous heat or tremendous cold and related physical and chemical conditions, mostly in space, there is no oxygen, except on earth, hence cometic material is likely to undergo incomplete burning process i.e., carboxynation to disintegrate, decompose or weathering the material according to their nature. That's why tektites are considered cometic material or may be the debris of Interstellar space or Interplanetary space, which goes under incomplete burning, mostly disintegration, decomposition or weathering, hence it appears black i.e., disintegration without oxygen (incomplete burning process), irrespective of temperature because many unknown biological and chemical processes are going on in the universe continuously, so different kind of objects of universe shows different colors of their disintegration process. Incomplete burning gives rise to carbon monoxide, soot or coke, which is coated on the particular material.

According to geology or soil, attributed pigmentation of native geology does not appear in tektite rock, according to their native source, some researchers assume that tektites are bumping balls emitted from volcanic eruption or similar events. If it is meteorite impact product, then it becomes porus, spongy and lighter compounds, then only it can be thrown in earth's environment and settle down. It is so light, density is very less, that's why it can be flung in their air and its density will always be lesser than water, may be possibly. But tektite rock is not porus in nature. According to Meteorite Impact Mechanism (MIM in short), tektite is oxidized product of basalt, but still it does not match tektite rock in color and grooves feature. The oxidized rocks or products of basalt is impact melt impactites (fused silica glass), impact breccias etc., in short oxides of basalt. The oxides of basalt impact melt, impactites, impact breccias, because Igneous rocks being of two types i. volcanic i.e., basalt, pumice, obsidian etc. and ii. Plutonic rocks like granite, gabbro etc., these are of primary oxidised process. After the meteorite impact on these rocks, secondary formation i.e., in presence of oxygen (MIM), i.e., fully oxidized in presence of Oxygen. But tektite rocks are not similar to secondary oxidised product of either volcanic or plutonic rocks example Impact melt, impactites, impact breccias etc., they do not appear black or have any grooves feature, or cratering feature so one possibility is that tektites rock formation is extra terrestrial process. The cometic material was the precursor of tektite formation, as comets are known to contain compounds of carbon and Silicates[7], i.e., high percentage of silica (SiO_2) is found.

It is known that large amount of cosmic dust falls on earth every year. This dust (of cosmic origin), it is assumed to be the leftover debris or remnants of comets crossing the earth's orbit, while its journey through the solar system around the sun. Since large part of the earth is covered by seas and oceans, this cosmic dust falls in the seas and oceans. Hence from the time water came on earth, large amount of these dust may have been deposited at the bottom of the seas and oceans from time immemorial. The findings of microtektites at the bottom of the seas and oceans as sediments is inferred to be related to a comet leftover debris or remnants, during its travel on its path around the sun and when the earth travels on its orbit around the sun, passes through these components, which are pulled towards it. Cratering feature is observed on meteorites surface[8], whereas grooves feature and some minor cratering feature has been observed on some tektite surface (Figure-11,13) and on most of the tektites under study shows these features. Consider the image in Figure-13, Czech tektite showing cratering feature on its surface in the middle and in Figure-14 image of a Bennu asteroid showing similar feature. These features are not observed on terrestrial rocks.

Some researchers are of the opinion that tektites were formed from meteorite impact on target earth rocks and soil. Consider the formation of meteorites: Meteorites are of extra terrestrial origin. Meteorites also contain Si (Silicon), this applies to iron meteorites and SiO_2 (Silica), this applies to stony iron and stony meteorites. But compared to tektites Si and SiO_2 are lesser in percentage than meteorites. In iron meteorites Si is even lesser that that in stony meteorites. Meteors when come in contact with earth's atmosphere, due to their high velocity in which they come to wards the earth, enter the earth's atmosphere and are completely burnt or oxidized i.e., in presence of oxygen, they form what are known as meteorites i.e., complete burning process of meteor takes place, but tektites (considered as cometic material) are of entirely different nature, are considered to be incomplete burnt material of a comet, whereas meteorites are completely burnt material of a meteor. Tektites were formed in absence (lack) of oxygen or sparingly in presence of oxygen; whereas meteorites fallen on earth were formed in presence of oxygen. Complete combustion of meteorites takes place when fallen on earth, but tektites formation incomplete combustion had taken place. Detail difference between tektites and meteorites is given in Table-6. In short, the process of formation, the source and origin of tektites differentiates tektites from meteorites.

Consider the formation of impact melt (impactites): When meteorite impacts on the earth surface, the target rocks and soil goes under tremendous heat and pressure, this melts the target rocks and soil into secondary formations known as impact melt (impactites) or fused silica glass, in which case the percentage of silica is higher than meteorites and even tektites. The physical features and chemical compositions changes completely. This process also takes place in presence of oxygen and the target rocks and soil are completely burnt or oxidized (i.e., complete combustion takes place), and the secondary components formed are known as impact melt or impactites or fused silica glass. Tektites were not formed in earth's environment i.e., in presence of oxygen. They were formed in absence (lack) of oxygen. Hence the formation of tektites differentiates tektites from formation of impact melt or impactites.

It is to be kept in mind that each meteorite fallen on earth, may or may not form craters, and if formed craters, then it will be of different nature altogether. Meteorites fallen on earth are different for different impact sites. Naturally target rocks and soil will also be different in each case. Each meteorite impact cannot produce similar color and similar surface feature as that observed on tektites. These features are not observed on secondary formations. The meteorite impacts which took place at different intervals or periods of time scale and formed secondary components, are dependent on various factors such as meteorite type, target rocks and soil on which its impacts, the topography of the area of impact, the geology, geomorphology and geography of the place of impact, environmental conditions existing during the impact period, temperature and pressure at the time of impact and finally which material is available at the time of impact to give rise to secondary formations from primary components.

From the information of tektite finds, it shows that they were found near the coast, which implies that they were found near the seas and oceans, not near any meteorite impact sites, if they were found near any meteorite impact sites, then it is likely that they were transported from an unknown source through an unknown event of unknown nature.

Consider the meteorite impact craters in Indian sub-continent, which are known to be the oldest. Dhala Crater, Madhya Pradesh, which was formed >2.1G (billion years)[9]. Kaveri crater, Southern Peninsula, formed between 800-550Ma[10]. Ramgarh Crater, Rajasthan, also known to be the oldest, findings of any tektites from these craters has not been reported or known.

It is inferred that tektites are not earth originated material as per this study because they were lying on the earth surface from unknown periods of time scale till their finds, without any disintegration and without any weathering effects on them; in short earth elements had no effect on them.

Formation of volcanic rocks also takes place in presence of oxygen i.e., complete combustion or complete burning process takes place, in these types of rock formation complete burning process is involved. The process of tektite formation is totally different from formation of volcanic rocks; therefore it differentiates tektites from volcanic rocks. Volcanic eruptions occur every year on earth surface. But tektites formation from volcanic eruptions has not been known or reported. Earth volcanic rock known as Obsidian is known, which looks black, and has similar chemical composition to that of tektites, but there is a major difference between both. Comparative chart of different volcanic rocks and plutonic rocks are shown in Table-5.

Consider the formation of fulgurite rocks: Fulgurite rocks are formed when lightning strikes on the rocks and soil of earth surface, usually on sands, which show high percentage of SiO_2 (silica). When lightning effect develops in the earth's atmosphere, and reaches the ground, due to high temperature, melts the original rocks and soil and forms fulgurite rocks of secondary nature. This process also takes place in the presence of oxygen. The formation of fulgurite rock is a complete burning process, i.e., complete combustion takes place and the rock is completely oxidized. Formation of tektites is different. Fulgurite rocks are formed in earth's environment, whereas tektites were formed in absence (lack) of oxygen, i.e., not in earth's environment. In short, the process of tektites formation differentiates tektites from fulgurite rocks.

Findings of Tibetan tektites on Tibetan land is surprising (Figure-18,19), because as per known information, there are no impact craters found. It is of the opinion that since most of the tektites were found near the seas and oceans, it is possible that in some unknown geological era Tibetan land was at sea level. Velikovsky stated that nineteenth century scientist, while doing the studies of the Himalayas were amazed when they came across fossils of marine animals. This was the evidence that the Himalayas had risen from beneath the sea[11]. If considered that Tibetan tektites were formed after upliftment of Tibetan land in some unknown era, would it show similar physical features to that of tektites found near the coast of seas and oceans? At such a height, where meteorite impact crater is unknown? Tektite formation at such a height is a question? But they all show similar physical features and chemical composition with respect to rest of the tektites, which suggest that in some unknown geological era Tibetan tektites were lying here, during this period i.e., prior to the upliftment of Tibetan land, as tektites found all over the world show same physical features and chemical composition, proving that they all are of one single target component i.e., possibly of cometic material origin. Findings of Tibetan tektites at such a height is not a coincidence, inspite of such an upheveal, millions of years ago[11], they were preserved against all natural calamities and cataclysm, which may have taken place on earth from time to time, it is not a coincidence.

It is of the opinion that the binding force in tektites may be much stronger than earth rocks and meteorites, which is why environmental conditions or weathering or climatic conditions had no effect on them, regardless of them lying on the earth surface for unknown period of time scale. This is possibly due to tektites are not earth originated material. The binding force keeps the whole rock intact and this may possible be due to high content of silica and carbon compounds of which the comets are made up of Sagan C. and Druyan A.[7]. The incomplete burning process may have binded the silica and carbon of which the comets are composed of in such a way, that disintegration due to weathering had no effect and hence may have remained as they were for years till they finds.

An incident of comet encounter with planetary bodies had taken place and has been reported. Lexell's comet which appeared in 1767 was captured by Jupiter and not until 1779, did it free itself from this entanglement[12]. Detail work conducted by Krinov on 'Tunguska Event', which took place in 1908, came to the conclusion that the Tunguska meteorite was in fact a comet[13]. This event is of very recent one i.e., it took place in 1908 (117 years back). If as per studies conducted by Krinov, regarding Tunguska object was a comet[13], then there is every possibility of closest approach of a comet near earth and having a close encounter in some remote past, and also there is every possibility of the cometic material fallen on earth to give birth to stones of entirely different nature known as tektites. Similarly in recent years, an incident of comet impact on Jupiter had taken place. A comet named Shoemaker Levy-9 crashed on Jupiter in 1994.

The impact of a comet Shoemaker Levy-9 on Jupiter in 1994 is the only evidence that recently took place, shows that impact of a comet on any planetary bodies of the solar system is possible. But the close encounter of a comet with earth may be once in millions of years. Jupiter is more massive and bigger in size than earth. Due to its massiveness, it can change the path of any comet passing nearby, similar to Lexell's comet of 1767[12], but earth like planets, which are smaller in size and less massive than Jupiter, a comet approaching earth and having a close encounter , once in a million years, one can imagine the fate of the earth during that event. If comet Shoemaker Levy-9 can impact on Jupiter, the largest planet, there is every possibility of cometry impact on planetary bodies of smaller size.

It is to be kept in mind that formation of tektites involves two factors (1) Tektites were formed in remote past, and (2) They were never formed on earth, but were formed in space as per the studies conducted through this paper. Formation of Meteorites from meteors, formation of impact melt or impactites (fused silica glass) from meteorite impacts, formation of volcanic rocks from volcanic eruptions, and finally formation of fulgurite rocks from lightning strikes on the ground, all these formations have taken place in earth's environment which has been considered as a possibility source for formation of tektites, where high heat phenomena is involved, but none of the above factors show any resemblance to tektite formation because tektites were formed in space i.e., not in earth's environment. They are the product of incomplete burning process of a cometic material. Hence the only solution left for source, origin and formation of tektites lies in the extra terrestrial nature for which it has already been discussed above.

The formation of tektites therefore is a process not related to any Earth events, but a process of unknown nature which formed many years back in space and when fallen on earth were as it is, without any effect of weathering conditions and is of totally different nature never observed on Earth, which shows that tektites are not ordinary rocks but of extra ordinary nature. The comet encounter with earth in remote past is the only solution to solve the mystery of source, origin and formation of tektites, which is explained satisfactorily through this paper.

If considered that tektites are of extra terrestrial nature, i.e., components of a comet, then there is every possibility to infer that there must be a store house of Silicon (Si) on the outskirts or far reaches of our solar system, where comets of long period come from or from Interstellar space, the comets are supposed to be the remnants of our earlier solar system or remnants or debris of super nova explosion, because they are found at the far reaches of our solar system and because they have high percentage of SiO_2, which have never been found in extra terrestrial components.

Our postulation suggest that tektites are derived from a comet close encounter with earth i.e., they are of cometic origin. There are Australian tektites, China tektites, Tibetan tektites and Philippinite tektite, all showing oxide composition of similar ratio and in similar proportion, it is not a coincidence, which clearly indicates that the original component from which these type of rocks were formed, are of one and the same component i.e., formed from one target rock.

Figure-1: China tektite with grooves feature seen on the surface.

Figure-2: China tektite with grooves feature seen on the surface.

Figure-3: Czech tektites with grooves feature.

Figure-4: Czech tektites with grooves feature.

Figure-5: Czech tektite with a glaze on upper part.

Figure-6: Czech tektite with grooves Feature on the surface.

Figure-7: Czech tektite with grooves feature.

Figure-8: Czech tektite with grooves feature.

Figure-9: Czech tektite with grooves feature.

Figure-10: Czech tektite with grooves feature.

Figure-11: Czech tektite with grooves feature and Minor cratering features seen on the surface.

Figure-12: Czech tektite with grooves and minor cratering features seen on the surface.

Figure-13: Czech tektite with grooves feature at side, in the middle a cratering feature is seen and below that a glaze is seen (Cratering feature is similar to Bennu asteroid).

Figure-14: Image of a Bennu Asteroid[14].

Figure-15: Czech tektite with smooth feature on top and grooves feature on sides.

Figure-16: Czech tektite with grooves feature.

Figure-17: Czech tektites with black color and grooves feature on the surface. Cratering feature is seen on left hand side down.

Figure-18: Tibetan tektite with grooves feature. Cratering feature is also observed.

Figure-19: Tibetan tektite with grooves feature, a small crevice is seen at upper left and cratering feature.

Figure-20: Philippinite tektite. Grooves feature seen on the surface and cratering feature is observed.

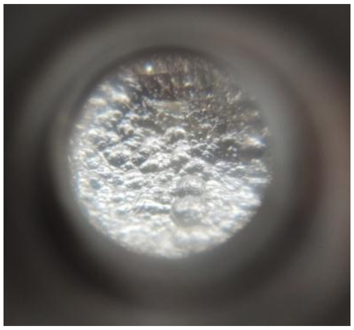

Figure-21: Tektite observed under Student microscope of 20X. The bubble type feature seen shows that the tektites had undergone a high heat phenomena before solidification.

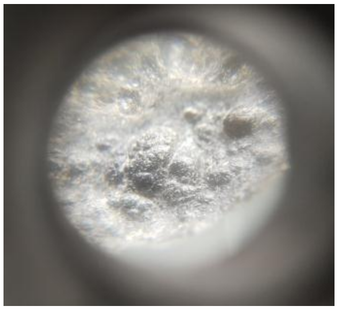

Figure-22: Tektite observed under Student microscope of 20X. The bubble type feature seen shows that the tektites had undergone a high heat phenomena before solidification.

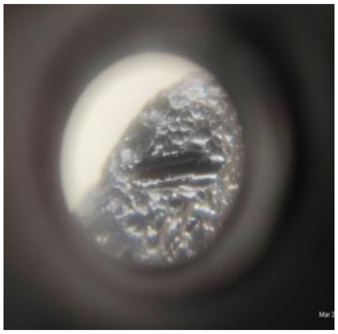

Figure-23: Tektite observed under student microscope of 20X. The dark black component seen in the middle surface of the tektite is inferred to be of meteoritic component is seen, because on the black component minute crater like feature is observed.

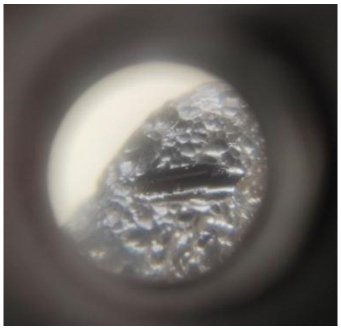

Figure-24: Image of tektite observed under Student microscope of 20X. The feature seen is similar to iron meteorite. The black component is inferred to be of meteoritic component.

Figure-25: Earth plutonic rock – Gabbro.

Figure-26: Earth plutonic rock – Granite.

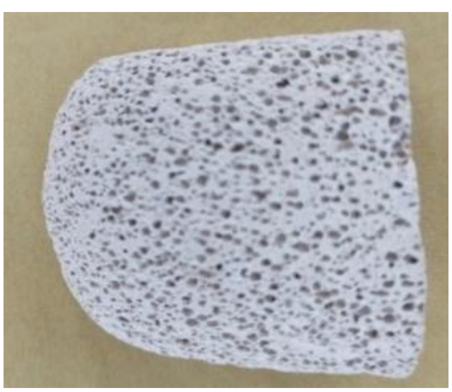

Figure-27: Earth volcanic rock - Pumice.

Figure-28: Earth volcanic rock – Obsidian.

Figure-29: Earth volcanic rock – Lava stones, Bali.

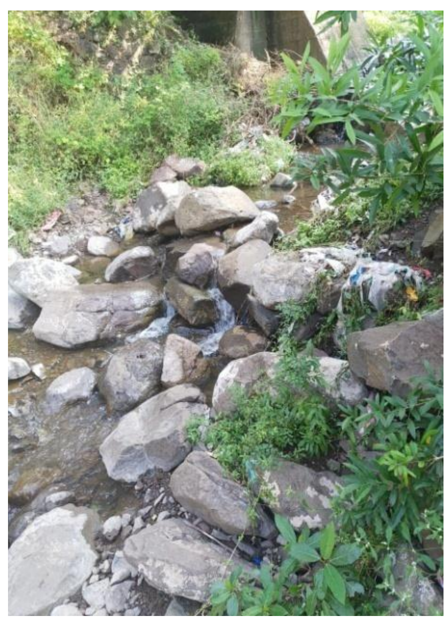

Figure-30: Earth volcanic rock – Basalt.

Table-1: Physical features of Czech tektites, China tektites, Tibetan tektites and Philippinite tektite.

Samples↓ / Parameters→	Wt in gms	Dimensions in cm.	Density g/cc	Color	Characteristic feature	Shapes	Lustre
Czech tektite 1	18.0817	3.5 x 1.8 x 2.0	2.26	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 2	23.3059	3.6 x 2.1 x 1.5	2.33	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 3	19.1632	3.3 x 1.8 x 1.8	2.4	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 4	19.3625	3.3 x 1.8 x 1.8	2.42	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 5	15.602	2.9 x 2.4 x 1.8	2.6	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 6	12.1474	3.2 x 1.4 x 1.5	2.02	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 7	55.528	5.0 x 3.4 x 2.1	2.22	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 8	11.0399	2.7 x 2.0 x 1.2	1.84	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 9	6.8107	1.9 x 1.6 x 1.8	2.27	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 10	8.2121	3.5 x 1.3 x 1.4	2.05	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 11	10.8629	2.7 x 1.4 x 1.4	2.17	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 12	10.7322	2.1 x 2.1 x 1.3	2.15	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 13	10.9703	2.9 x 2.2 x 1.4	2.19	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 14	8.0844	2.2 x 2.2 x 1.4	2.02	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 15	8.5422	3.4 x 1.8 x 1.0	2.14	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 16	10.8371	2.3 x 2.2 x 1.5	2.71	Dark black	Grooves on its surface	Irregular	Earthy
Czech tektite 17	10.2269	2.1 x 2.1 x 1.3	2.05	Dark black	Grooves on its surface	Irregular	Earthy
China Tektite 1	45.4241	4.4 x 3.0 x 2.7	2.3907	Light black	Grooves on its surface	Egg shaped	Earthy
China tektite 2	57.5543	4.2 x 2.5 x 2.1	2.398	Light black	Grooves on its surface	Egg shaped	Earthy
Tibetan tektite 1	13.6449	3.3 x 1.9 x 1.2	2.27415	Dark black	Grooves on its surface	Elongated	Earthy
Tibetan tektite 2	4.4369	2.7 x 1.2 x 0.8	2.21845	Dark black	Grooves on its surface	Elongated	Earthy
Philippinite tektite	9.31	2.5 x 1.4 x 1.5	2.3275	Dark black	Grooves on its surface	Oval	Earthy

Table-2: Oxide composition of China Tektites, Tibetan tektites and Philippinite tektite**.**

Oxides↓/ Tektites names→	China Tektite 1	China tektite 2	Total	Average	Tibetan tektite 1	Tibetan tektite 2	Total	Average	Philippinite tektite
SiO_2	74	74.3	148.3	74.15	73.3	75.2	148.5	74.25	74.1
Al_2O_3	12.6	12.3	24.9	12.45	14.1	13.3	27.4	13.7	12.8
Fe_2O_3	4.89	5.02	9.91	4.955	5.04	4.35	9.39	4.695	4.79
K_2O	2.75	2.86	5.61	2.805	1.79	2.27	4.06	2.03	2.71
CaO	2.47	2.4	4.87	2.435	1.89	2.09	3.98	1.99	2.69
MgO	1.63	1.48	3.11	1.555	2.72	1.95	4.67	2.335	1.95
TiO_2	0.791	0.818	1.609	0.8045	0.614	0.7	1.314	0.657	0.73
SO_3	0.265	0.226	0.491	0.2455	0.349				
P_2O_5	0.251	0.214	0.465	0.2325					
Cl	0.111	0.085	0.196	0.098					
MnO	0.09	0.094	0.184	0.092	0.082	0.081	0.163	0.0815	0.089
ZrO_2	0.05	0.05	0.1	0.05	0.042	0.04	0.082	0.041	0.045
BaO	0.048	0.046	0.094	0.047	0.036	0.035	0.071	0.0355	0.039
SrO	0.016	0.016	0.032	0.016		0.014			0.017
Cr_2O_3	0.008	0.011	0.019	0.0095	0.018				0.01
ZnO	0.004								0.003
NiO	0.004								0.002
CuO	0.003					0.003			
Co_2O_3	0.016								
V_2O_5					0.01				
Total	99.997	99.92		99.945	99.991	100.03		99.815	99.975

Table-3: Oxides composition of Czech Tektites by XRF in %.

Sr. No.	Oxides↓/Czech tektites →	1	2	3	4	5	6	7	8	9	10
1	SiO_2	73.8	74.2	75.8	75.4	74	76.4	75	80.6	78.1	76.5
2	Al_2O_3	10.8	12.4	12.8	12.9	12.5	12	12.8	10.9	12.4	13.8
3	Fe_2O_3	6.43	4.72	5.05	4.36	4.78	4.55	5.31	3.98	3.87	4.12
4	CaO	2.83	2.38	2.47	1.81	2.59	1.86	2.69	1.71	2.48	2.1
5	K_2O	2.46	2.76	2.72	2.09	2.76	2.1	2.97	1.84	2.11	2.41
6	MgO	1.6	1.91		1.94	1.83	1.76				
7	TiO_2	0.836	0.755	0.74	0.655	0.733	0.648	0.77	0.587	0.584	0.594
8	SO_3	0.566	0.319	0.208	0.377	0.308	0.262	0.247	0.236	0.243	0.339
9	P_2O_5	0.426	0.257		0.252	0.31	0.248				
10	MnO	0.12	0.085	0.088	0.078	0.086	0.081	0.092	0.081	0.073	0.071
11	BaO	0.052	0.039	0.041		0.038	0.037	0.043	0.032	0.028	0.036
12	Co_2O_3	0.033	0.015		0.013	0.014	0.015				
13	NiO	0.008	0.004	0.009	0.004	0.004	0.004	0.008	0.007	0.011	
14	ZrO_2		0.043	0.045	0.037	0.041	0.041	0.048		0.037	0.035
15	SrO		0.015	0.018		0.016		0.018	0.018	0.015	0.014
16	Cr_2O_3		0.01	0.007	0.01	0.009	0.007				
17	Nb_2O_5		0.004					0.005			
18	CuO		0.004	0.005	0.003	0.003	0.004		0.003	0.005	0.006
19	ZnO					0.004			0.003		
20	V_2O_5							0.017			
21	Na_2O										
Total		99.96	99.92	100	99.93	100	100	100	99.997	99.956	100
Continued Czech tektites 11,12,13,14,15,16,17, Total, Average											

Sr. No.	Oxides↓/ Czech tektites →	11	12	13	14	15	16	17	Total	Average	
1	SiO_2	75.2	73	73.3	70.9	73.1	76	73.6	1275	74.9941	
2	Al_2O_3	13	12.4	13.2	13.6	13.7	12.1	13	214.3	12.6059	
3	Fe_2O_3	5.17	4.78	4.74	5.35	4.5	4.56	5	81.27	4.78059	
4	CaO	2.62	2.09	2.58	3.17	2.44	1.83	2.28	39.93	2.34882	
5	K_2O	2.8	2.22	2.8	3.22	2.6	2.55	3	43.41	2.55353	
6	MgO		1.9	1.92	2.21	2.16	1.72	1.93	20.88	1.89818	
7	TiO_2	0.76	0.71	0.72	0.86	0.7	0.69	0.77	12.11	0.71247	
8	SO_3	0.24	0.26	0.26	0.26	0.31	0.21	0.26	4.914	0.28906	
9	P_2O_5			0.27	0.25	0.27	0.21		2.492	0.27689	
10	MnO	0.09	0.08	0.09	0.1	0.08	0.08	0.09	1.468	0.08635	
11	BaO	0.04		0.04	0.04	0.04	0.04	0.04	0.585	0.03898	
12	Co_2O_3								0.09	0.01792	
13	NiO								0.059	0.00651	
14	ZrO_2	0.05	0.04	0.04	0.05	0.04	0.04	0.05	0.635	0.04233	
15	SrO	0.02		0.02	0.02	0.01	0.01	0.02	0.207	0.01592	
16	Cr_2O_3		0.01			0.01	0.01	0.01	0.086	0.00956	
17	Nb_2O_5								0.009	0.0045	
18	CuO	0.01							0.039	0.00433	
19	ZnO								0.007	0.0035	
20	V_2O_5								0.017	0.017	
21	Na_2O		2.43						2.43	2.43	
Total		100	99.9	100	100	100	100	100		103.136	

Legend:	4. Czech tektite	8. Czech tektite	12. Czech tektite	16. Czech tektite
1. Czech tektite	5. Czech tektite	9. Czech tektite	13. Czech tektite	17. Czech tektite
2. Czech tektite	6. Czech tektite	10. Czech tektite	14. Czech tektite	
3. Czech tektite	7. Czech tektite	11. Czech tektite	15. Czech tektite	

Table-4: Comparison of Chemical composition of Czech tektites with China tektites, Tibetan tektites and Philippinite tektite, (avg values) in %.

Oxides↓ / Tektites→	Czech	China	Tibetan	Philippinite	Total	Average
SiO_2	74.9941	74.15	74.25	74.1	297.4941	74.37353
Al_2O_3	12.6059	12.45	13.7	12.8	51.5559	12.88898
Fe_2O_3	4.78059	4.955	4.695	4.79	19.22059	4.805148
K_2O	2.55353	2.805	2.03	2.71	10.09853	2.524633
CaO	2.34882	2.435	1.99	2.69	9.46382	2.365955
MgO	1.89818	1.555	2.335	1.95	7.73818	1.934545
TiO_2	0.71247	0.8045	0.657	0.73	2.90397	0.725993
SO_3	0.28906	0.2455			0.53456	
P_2O_5	0.27689	0.2325			0.50939	
Cl		0.098				
MnO	0.08635	0.092	0.0815	0.089	0.34885	0.087213
ZrO_2	0.04233	0.05	0.041	0.045	0.17833	0.044583
BaO	0.03898	0.047	0.0355	0.039	0.16048	0.04012
SrO	0.01592	0.016		0.017	0.04892	
Cr_2O_3	0.00956	0.0095		0.01	0.02906	
ZnO	0.0035			0.003	0.0065	
NiO	0.00651			0.002	0.00851	
CuO	0.00433				0.00433	
Co_2O_3	0.01792				0.01792	
V_2O_5	0.017					
Nb_2O_5	0.0045					
Na_2O	2.43					
As_2O_5						
PbO						
Total	103.13644	99.945	99.815	99.975		99.79069

Table-5: Comparison of Oxide composition of tektites with respect to Earth volcanic rocks and plutonic rocks in %.

Oxides↓/ Tektites names→	Tektites (average value)				Earth rocks					
	Czech	China	Tibetan	Philippi nite	Basalt (avg value)	Pumice	Lava stones (avg value)	Obsidi an	Granite (avg value)	Gabbro
SiO_2	74.9941	74.15	74.25	74.1	53.15	55.4	60.07	76.600	66.2	54.9
Al_2O_3	12.6059	12.45	13.7	12.8	26.84	4.32	20.79	2.970	13.3	15.25
Fe_2O_3	4.78059	4.955	4.695	4.79	11.95	1.82	7.22	1.960	5.885	8.17
K_2O	2.55353	2.805	2.03	2.71	0.935	0.389	1.35	1.530	3.81	1.295
CaO	2.34882	2.435	1.99	2.69	10.22	33.8	7.6	6.450	5.115	7.1
MgO	1.89818	1.555	2.335	1.95	4.353	0.407	1.5		4.37	4.915
TiO_2	0.71247	0.8045	0.657	0.73	2.005	0.164	0.82	0.225	0.867	1.57
SO_3	0.28906	0.2455			0.598	3.59	0.27		0.255	0.1825
P_2O_5	0.27689	0.2325			0.748		0.48	0.832		0.541
Cl		0.098			0.098			0.393		
MnO	0.08635	0.092	0.0815	0.089	0.151	0.044	0.17	6.610	0.084	0.0895
ZrO_2	0.04233	0.05	0.041	0.045	0.022	0.03	0.03	0.039	0.02	
BaO	0.03898	0.047	0.0355	0.039	0.013	0.011	0.06	1.020	0.047	0.032
SrO	0.01592	0.016		0.017	0.018		0.06	0.057		
Cr_2O_3	0.00956	0.0095		0.01				0.270	0.084	
ZnO	0.0035			0.003	0.01		0.014	0.141		
NiO	0.00651			0.002	0.01	0.003	0.003			0.017
CuO	0.00433				0.041		0.01	0.141		
Co_2O_3	0.01792						0.018			
V_2O_5	0.017				0.078		0.03			
Nb_2O_5	0.0045									
Na_2O	2.43									5.825
As_2O_3						0.005				
PbO				99.975				0.809	0.003	
Total	103.136	99.945	99.815	99.975	111.24	99.983	100.495	100.04 7	100.04	99.887

Table-6: Difference between meteorites and tektites.

Meteorites	Tektites
Meteorites are extra terrestrial in nature.	Tektites are extra terrestrial in nature. (Postulated as per this study).
Colour depends on the class.	Typical dark black colour.
Formed in presence of oxygen. (Complete burning process is involved).	Formed in absence (lack) of oxygen. (Incomplete burning process is involved).
Has cratering feature.	Has grooves feature and also cratering feature.
Origin from asteroidal belt.	Origin from Interstellar space.
Weather in due course.	Weathering conditions has no effect.
Source and origin from asteroids.	Source and origin from comets. (Postulated as per this study).
Density varies according to class.	No variation in density.
Si or SiO_2 is lesser than tektites.	SiO_2 is higher than meteorites.
Chemical compositions depend as per class.	Chemical Composition mainly contains compounds of SiO_2, Al_2O_3, Fe_2O_3, K_2O, CaO etc.

Conclusion

From the results of physical feature parameters (Table-1), results of chemical composition by XRF (Table-2,3,4), comparison of tektites with earth volcanic and plutonic rocks (Table-5), comparison of formation of meteorites from meteors (Table-6), formation of impact melt or impactites from meteorite impact , formation of fulgurite rock from lightning strikes on the earth surface and finally formation of volcanic rocks from volcanic eruptions, the observations of cratering and micro cratering feature on tektite surface through student microscope, and black nature component suspected to be of meteorite origin on tektite surface (Figure-13,23,24), and discussions in detail considering all the criteria i.e., tremendous heat factor involved for the formation of tektites, but none of the above, show any resemblance to tektite formation.

It is therefore concluded: i. Tektites are not fully oxidized rock (incomplete combustion burning process in vacuum). ii. Tektites are not the product of complete burning process i.e., similar to formation of meteorites, impact melt or impactites, fulgurite rocks or volcanic rocks, in other words it can be said that it is not the product of meteorite impact mechanism (MIM), because color, structural feature and density does not match with any rocks on the earth's surface. iii. So it is a possibility of cometic material which underwent incomplete burning process (Incomplete burning in indefinite time in space), otherwise it is not possible to explain color or structural feature, so ultimately it is the product of extra terrestrial body. A detail study is necessary through this direction.

It is not a coincidence why the tektites show similar physical features and chemical composition irrespective of their findings at different places on earth. There is some pattern of grooves formation on tektites surface, which is related to an unknown natural event. It is not a coincidence.

Tektites are the only evidence of a comet close encounter with earth in remote past. There are some facts hidden which are being neglected. If a close encounter of a comet with earth is possible once in a million years, then the components of the comet or cometic material falling on earth is also possible and the formation of tektites from these components is also possible. The components of the cometic material are the source and origin for formation of tektites.

Importance of work: At present there is no material or components of extra terrestrial nature having high percentage of SiO_2, which can be considered as a standard source for cometary components, especially the cosmic dust. Tektites being or is considered of extra terrestrial in nature, being of a comet material can be used as a standard source for any cometary material or any component of extra terrestrial nature of cometary origin in future. There are standards for Earth rocks, there are standards for meteorites, but no standard is available for cometic material or cometary components. Hence tektites can be considered as a good source of standard for cometic material or cometary components having high percentage of SiO_2. This dust is known to be of comet leftover debris or remnants. Tektites will be very helpful in classifying the cosmic dust! What is the origin of cosmic dust? Is it of comet origin? Or is it of interplanetary dust? Or is it of Interstellar dust or is it the leftover debris of earlier solar system? Or is it the remnants of a supernova explosion from which the sun and the planets were formed? What is it exactly of? In this case tektites can be a good standard source for analysis of this cosmic dust. Tektites being material of a comet, not only will it help to solve the above questions, but it will also help to solve the fundamental questions related to earth about what is the source of water on earth? And what is the source and origin of life to begin on earth?

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