INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

IJARIIT

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 4)
Available online at: www.ijariit.com

"White rusting of rocks"– The phenomena observed at Lonar crater lake

Jadhav Raju D
rajujadhav1010@gmail.com
Naushad Ali Sarovar Samvardhini, Mumbai, Maharashtra

Mali Harishchandra B.
harishchandra.mali@rediffmail.com
Naushad Ali Sarovar Samvardhini, Mumbai, Maharashtra

ABSTRACT

For the first time, white rusting/white coating of Silica on basaltic rocks has been observed at Lonar Crater Lake. Silica coating has been observed on basaltic rocks of Kilauea flow in Ka'u Desert on Hawaiian volcanic islands and has also been observed on the surface of Mars at Gusev Crater. The term white rusting/white coating of silica has been used for the same feature i.e., silica coating. White rusting /white coating phenomena observed on basaltic rocks of Lonar Crater Lake shows similarity to the silica coating observed on basaltic rocks of Kilauea flow in Ka'u Desert. Representative rock samples covered by white layer/white coating/white rusting were collected and after removal of the white-coated part were analyzed by XRF, showed that major oxide component was Silica (SiO_2) – 95-97 % mass of amorphous nature with minor quantities of SO_3, Fe_2O_3, Al_2O_3, CaO, and Cr_2O_3. The oxide content detected in white coating component at Lonar and that detected in silica coating on basaltic rocks of Kilauea flow in Ka'u Desert of Hawaiian volcanic islands shows good agreement which infers that similar processor unknown process may be operating at Lonar Crater Lake. From the studies carried by different researchers on silica coating on basaltic rocks of volcanic origin, it infers that the formation of white rusting at Lonar Crater Lake may be related to volcanic eruption or weathering conditions or physical changes due to climatic conditions existing at Lonar from the time the lake was formed. The white rusting is known to be a polymorph of silica in which SiO_2 value is found to be 95 – 97 mass %. This paper reports the first-hand information of observations and findings of white rusting/ white layer coating phenomena on basaltic rocks at Lonar Crater Lake on a preliminary basis and to put on record the works carried out regarding white coating phenomena with respect to silica coating on basaltic rocks of Kilauea flows in Ka'u Desert on Hawaiian volcanic islands. Phenomena with respect to silica coating on basaltic rocks of Kilauea flows in Ka'u Desert on Hawaiian volcanic islands.

Keywords— *Crater Lake rocks, Lonar, White rusting phenomena, Volcanic eruptions, Basalts*

1. INTRODUCTION

Lonar is a small town in Buldhana District of Maharashtra, India. A crater was formed due to a meteorite impact, the coordinates of which are 19°58'N and 76°30'E. This crater has attained importance due to its formation on basaltic rocks. The crater diameter is approximate 1.83km and the depth is approximate 150mtrs. The crater has a lake filled with saline and alkaline nature of water at the bottom. The soil at the lake basin is the sandy type and grayish. The lake is surrounded by thick green vegetation. On the periphery of the lake, temples are found in a ruined state, where two or three temples get submerged in the lake water when the water of the lake rises. The crater has a circular rim. There are some gorges on the rim, the largest one is known as Dharatirtha, where continuous water flows from beneath a temple. On the outskirts of the crater rim, powdery yellowish type of dust is observed which is known as ejecta blanket. A small depression on the North West of Lonar Crater is found which is known as little Lonar and named Amber Lake.

1.1 Some of the earlier works carried out on Lonar crater

Nandy and Deo mentioned that the formation of this crater or depression must have occurred not long after the Cretaceous period since when peninsula India did not experience any violent tectonic movement [1]. Son states that the Lonar impact crater, India, is the only young and well-studied, simple bowl-shaped crater excavated in continental flood basalts on Earth. The target rocks are basalts of the Deccan traps aged 65ma[2]. According to Maloof, the present day diameter is 1.88±0.05km [3]. As per Lafond and Dietz, Lonar crater is probably a meteorite crater but definitive information is lacking [4]. Jourdan states we propose a new impact age at 656±81ka for the Lonar crater [5]. The absence of influents and the alkalinity of the lake water would perhaps explain the fact that no fossil was detected in the silts in spite of their great antiquity [1]. As per Shinde and More, the alkalinity of the Lonar Lake is decreasing as the pH is ranging between 8.4 and 9.5 and calcium, magnesium and sodium concentrations are minimal due to which salinity of the soil is not high. But the water sample is having high chlorides, hardness, and salinity due to which the alkalinity of the water is in higher range [6]. Gaikwad and Sasane stated that from the results, it is clear that in our study area, the pH value of most of the groundwater samples is 10.5 [7]. But as per Pawar, the pH of Lonar lake water varies from 10.2 – 10.5 [8]. Komatsu studied Lonar crater and mentioned that investigations on hydrological processes at Lonar crater and its lake could provide useful insights to purported paleo-crater lakes presumably formed in the basaltic crust of Mars [9]. Hagerty and Newsom state that our results suggest that the Lonar crater has great potential as a laboratory to further study geochemical and hydrothermal processes that may be important on the surface of Mars [10]. Newsom mentions that in the presence of water, alteration of shocked and disrupted materials from impact craters the size of Lonar crater (1.8 km diameter) or longer can contribute to substantial mobile element transport on planetary surfaces [11]. Kumar states that the impact deformation structures of Lonar are essentially similar to those at other terrestrial craters emplaced in granites and clastic sedimentary rocks [12]. Chakrabarti and Basu mentioned that the Precambrian crustal basement beneath the Deccan traps is composed of amphibolites, granulites or sediments derived from them [13]. As per Son, the chemical data of major and trace elements show that they are rather similar to each other and very similar to the composition of Lonar target basalts [2]. Nandy and Deo stated that this limestone usually being siliceous would not completely go into solution. Lastly, nowhere in this region was the occurrence of limestone neither noticed nor struck in boreholes nor were the silts recovered high in CaO [1]. Morgan stated that iridium is probably the most sensitive indicator element for many types of Fe-rich meteoritic materials [14]. Stroube also stated that the results of this study suggest that impacts in basalt generate glasses which have essentially unaltered compositions of major rock and mineral-forming elements, as compared to the present basalts. Fractionation, if any exists, would be limited to the number of highly volatile elements not determined in this study [15]. Nayak stated that thus, from the foregoing possible explanations, it is apparent that no single explanation provides an unequivocal understanding of the mechanics of plagioclase-maskelynite transformation [16]. Sarkar mentioned that the development of planar deformational features on the cavity filling quartz grains as observed from petrographic and SEM analysis can be utilized as a supplementary evidence for a meteorite impact at Lonar [17]. Misra from his studies concludes that our conclusion from this assessment is that some type of chondrite may have been the most likely impactor for the Lonar crater. However, it is not possible to identify the specific chondrite group of an impactor for the Lonar crater with the available data [18]. As stated by Murali, these tektite-like bodies from the Lonar crater seem to be related to the local basalts by silica addition resulting in the overall dilution of the rest of the major and trace elements [19]. Wright stated that a secondary objective is to introduce Lonar crater, India, a terrestrial crater in Deccan Traps flood basalt, as a viable analog for martian impact craters with respect to target rock composition and the production and composition of impact glasses [20]. Chakrabarti and Basu mentioned that the high $^{207}Pb/^{204}Pb$ ratios at low $^{206}Pb/^{204}Pb$ ratios of the impact breccias indicate a contribution from ancient continental crustal material [13]. As per Nayak, it is suggested that more studies of shocked basalt material from the Lonar crater will provide valuable information not only with regard to maskelynite but also to understand the pressure-temperature history in an impact environment [16]. Lafond and Dietz stated that although the discovery of meteorite fragments is unlikely at an impact site of this antiquity, a search should nevertheless be made [4]. According to Rajasekhar and Misra, the nature and amplitude of gravity and magnetic anomalies recorded over Lonar Lake, therefore, tentatively suggest that it represents an impact crater, which can be confirmed from modeling of the sources causing these anomalies [21]. Kraft studied silica coatings on the surface of Mars and concludes that our experiment shows that continuous and thin, <10µm coatings of silica completely mask a basaltic substrate [22].

2. METHODOLOGY

Representative rock samples covered by white rusting/ white coating / white layers were collected from Lake Basin figure 1and 2. The rocks were washed with distilled water to remove all the contaminants. After drying, the weight of these rocks taken was 16.47153g and 17.18875g. The white rusting/white layer around these rocks was removed by scraping the rock with a sharply pointed biceps. The powdered form was collected and kept in a plastic box for further analysis. Observation through a stereo binocular microscope was undertaken, and later, the powdered samples were sent for XRF analysis for elemental composition Table 1 and 2. To understand the mechanism of white rusting/white coating phenomena on the rocks at Crater Lake, analysis by XRF was carried out. The details of which are given in table 1 and 2. After this work, the scraped rocks were weight to find the difference of white rusting encapsulating the rocks.

2.1 Experimental Results

From the observation of the rock samples, it is found that the white rusting has encapsulated the rocks which are lying near the Crater Lake. The color of the encapsulated mineral or component was found to be milky white. The collected scraped powder was found to be white in appearance i.e., amorphous in nature figure 7. Observation through stereo binocular microscope showed the sample to be of amorphous nature of unknown mineral, figure 7. Analysis by XRF was carried out. Detail analyses are shown in table 1, 2, 3 and 4. The encapsulated part had covered a thin section of the rocks under study. From the results by XRF analysis (for scraped white rusting of two rock samples) Table 1 shows in sample one, SiO_2- 95.374 mass % with negligible quantities of SO_3, Fe_2O_3, Al_2O_3, CaO, Cr_2O_3 mass %. Sample two shows SiO_2- 97.24 mass % with negligible quantities of SO_3, Fe_2O_3, MnO, CaO, Cr_2O_3 mass %. The results by XRF confirmed that the tiny amorphous structures observed under the binocular microscope are of Silica of amorphous nature. Table 3 and 4 show that the rocks encapsulated by white rusting after removal of some white coating, SiO_2 was found to be 99.4 and 99.5% mass. After this work, the weight of the rocks was taken and found to be 16.235g and 17.0949g, the difference was 0.23653g and 0.09385g.

2.2 Observations

It is observed that this Silica rusting is not washed out by rainwater nor does it disintegrate by climatical conditions or weathering conditions. Since it is a crystal powdered material, it does not disintegrate the host stone, this rusting is not pulled out easily when touched or scraped with fingernails. Weathering conditions also have no effect on these white rusting or Silica rusting. It is observed that temple stones which are on the periphery of the Crater Lake are found to be affected the most. White rusting or white layer coating on rocks is seen in the particular direction only i.e. north-west side of the lake and to a lesser extent on the south-west side of the lake and near Kamalja Devi temple. But the major portion of these phenomena seen on rocks is on the northern side of the crater. It was also observed that when the scraping work was carried, the Silica rusting encapsulated the glassy transparent rock figure 1 and 2.

3. RESULTS AND DISCUSSIONS

The results obtained by XRF analysis shows that the major component in white rusting is Silica (SiO_2) with other oxides in negligible quantities. Detail analysis is given in Table 1 and 2. The analyses carried out shows that the percentage of silica (SiO_2) was found to be between 95-97 % mass. Since the major oxide component is Silica, the white rusting process is found to be due to Silica content and hence it is termed as white rusting or white coating. The results by XRF of white rusting/white coating on basaltic rocks of Lonar Crater Lake is found to be in good agreement with Chemtob results of Kilauea flow in the Ka'u Desert.

From these results, it shows that the rocks at Crater Lake being of basaltic origin are coated by this white rusting. As per Chemtob, Silica coating phenomena, seen on basaltic rocks of Kilauea flow in K'u Desert, is due to volcanic eruption. From the results by XRF shows that these rocks contain 95-97 % mass SiO_2 and because the color of silica (quartz) is white, hence white rusting phenomena is observed. At Lonar, a volcanic eruption took place 65ma ago throughout Maharashtra. After this, there has been no volcanic eruption. White rusting phenomena has not been observed on any basaltic rocks of Deccan plateau except at Lonar because, the factors necessary for the formation of white rusting phenomena, the environmental conditions are found to be existing at Lonar and not at another place. The volcanic activity ceased long back. In the opinion of the earlier workers, the formation of the crater is due to volcanic eruption. But there is no proof for such an assumption. Hence in the absence of any volcanic activities in recent years, white rusting phenomena has taken place. Therefore this phenomenon cannot be attributed to a volcanic eruption. The factors necessary for the formation of white rusting/white coating is a volcanic eruption, along with the semi-arid type of environment, water in any form like meteoric water, groundwater, surface water, rainwater etc., halogen group elements, which may favor the formation of white rusting. At Lonar since no volcanic activity has taken place after 65 ma, or it has taken place has not been reported or recorded, this phenomena cannot be attributed to volcanic eruption, but other factors may also be responsible for its formation like semi-arid type of environment, water, halogen group elements in lake water where presence of F, Cl, Br being highly corrosive can have adverse effect on the basaltic rocks at the lake periphery. Hence the mechanism for the formation of white rusting/white coating of silica on basaltic rocks at Lonar Crater, though volcanic eruption has taken place long ago, and as is observed in Kilauea flow on Ka'u Desert and reported by Chemtob may be totally different. The crater was formed 656 thousand years back [5].

Chemtob carried studies on Kilauea flow in Ka'u Desert of Hawaiian volcanic islands, which is supposed to be one of the oldest volcanic eruptions, being active and has recently erupted, white rusting phenomena has been observed. At Lonar whether volcanic eruption has taken place or not is unknown or if the volcanic eruption has taken place after crater formation, no information is available. If considered that white rusting phenomena is the output of the volcanic eruption which gave rise to crater formation as per earlier workers opinion, then for such a large time span, the white rusting process may have started and as observed today it may be a meta-state of a polymorph of silica. This meta state of a polymorph of silica has not been observed or reported from volcanic eruption site from Lonar by earlier workers, or from any of the impact crater site but this metastable form is observed at Lonar in the same rock of basaltic origin. The silica content in the white rusting on a basaltic rock, being dominant tries to leachate out other oxides in the environment which are in minor quantities and attain a fully stable state in which SiO_2 may be 99.4 -99.5% mass. The white rusting or coating of silica is nothing but a polymorph of silica in a metastable state i.e., unstable state. This is also known as polymorphism in which silica exists in many forms. Here at Lonar silica is found to be found in one form, i.e., white coating or white rusting which is also observed at another volcanic eruption site. The factors necessary for the formation of white rusting state exist at Lonar and hence this phenomenon is observed. Volcanic eruption if has taken place then it must be after crater formation because temples were built in the 12^{th}-century[25], and temple stones are observed to be covered by white rusting, the stems of trees, bushes, twigs etc., are also found to be covered by white rusting. Hence it suggests that volcanic eruption has taken place after the temples were built.

All the factors necessary for the formation of white rusting phenomena as stated by Chemtob, in studies carried out on Kilauea flow in Ka'u Desert, and other workers who have carried out similar works on other volcanic eruption sites, for the formation of the white coating, are also found at Lonar crater. There is no doubt that volcanic eruption at Lonar must have taken place i.e., after the formation of a crater, otherwise, the white rusting process would not be possible or would not have occurred without a volcanic eruption. Hence volcanic eruption is the primary factor for the formation of white rusting phenomena as is observed and reported on Kilauea flow in Ka'u Desert. Basalt rich in SiO_2 content may show this property of white rusting and this can only be possible from volcanic eruption because at the time of volcanic eruption the basaltic rocks (volcanic rocks) contain higher % of SiO_2, in due course, the dominant mineral tries to leachate out the other minerals which are found to be in minor quantity and the dominant mineral tries to attain the stable state.

White rusting phase is the oxidizing process just like iron oxide or oxidation of iron which contains a major amount of oxides. It is conservative and conversion process, not disintegration process. In white rusting, SiO_2 (Silica) is dominant. It is seen that as SiO_2 increases, the other oxides are found to decrease. The white rusting phase is seen in figure 1-6, 8-11.

The factors responsible for formation of white rusting phenomena as mentioned by Chemtob such as volcanic eruptions, semi-arid type of environment, water vapor or meteoric water, rainwater or underground water, acidic fumes released by volcanic process, hydrothermal or epithermal, halogen group elements etc. [23], all these factors are also found to exist at Lonar Crater.

Hence it becomes necessary to study and understand how this metastable state has been attained or what the mechanism behind this change is. This is the only possibility of white rusting phenomena to take place at Crater Lake.

Silica coatings formation occurs in semi-arid environment [23]. Lonar has a semi-arid climate, which has resulted in white rusting formation. The oxide composition stated by Chemtob and oxide composition through this study is in good agreement. Detail study is in progress to know what mechanism is at work for the phenomena of white rusting/white coating phenomena at Lonar Crater Lake because as per Chemtob silica coating is related to volcanic activity [23]. Volcanic activity may have taken place but has not been reported or recorded, without which white rusting phenomena may not be possible. The temple stones, figure 5, and tree stems standing in the waters, the branches of twigs and bushes, figure 10 and 11, covered by white rusting shows that volcanic event must have taken place. The temple stones and tree stems stand witness to the event which may be related to the volcanic eruption. Temples were built in the 12th-century [25]. Hence volcanic eruption has taken place after the temples were built. It is also to be stated that the white rusting or white coating phenomena has not been observed on any of the basaltic rocks (volcanic rocks) of Deccan Plateau except at Lonar Crater this phenomenon has been observed.

4. CONCLUSIONS

From the analysis results of XRF on scraped white rusting/white coating of different rocks and from discussions, it is found that white rusting or white coating feature has been observed on a basaltic rock, which may have been attained through volcanic eruption. The white rusting feature observed over basaltic rocks, may be a form of silica i.e., a polymorph of silica having 95-97% mass, The white rusting is the metastable state and attains a stable state in due course of time having SiO_2 in the range 99.4-99.5% mass, which is possible from volcanic eruptions. Hence it can be concluded that for the white rusting process to take place, the rocks must have 95% SiO_2, which is attained at the time, the volcanic eruption takes place and white rusting formed which can be attributed to volcanic activity and weathering conditions i.e., semi-arid environment with other factors existing at Crater Lake. The process may have started from the time volcanic eruption took place and today it is observed as white rusting. Whether this phenomenon is related to the volcanic eruption of 65 ma or recently erupted is unknown. Yet this is observed. The phenomena of white rusting observed on basaltic rocks at Lonar crater, will be helpful in studying similar features observed on Mars, Lonar will be the best analogue because volcanic activity on Mars has ceased long back, yet white rusting or silica coating has been observed, similar to Lonar where volcanic activity has also ceased long back. It may also help in knowing the climatic or environmental conditions existing at that time and how, the polymorph form of silica exist at Lonar and which are the minerals related to silica, involved in the formation of the white rusting process.

Above all, it is to be kept in mind that uniqueness of Lonar Crater i.e., high salinity and high alkalinity in which the surrounding air contains saline chemical species and alkaline chemical species in the air. So the air around the Crater Lake may also be responsible for exhibiting this type of phenomena. This fact cannot be neglected because this abnormal air quality has specific chemicals in nature.

5. ACKNOWLEDGEMENT

The authors wish to thank the Microbiology Department of Ramnarain Ruia Autonomous College, Matunga (East), Mumbai for their kind help in availing their Lab facility for observation of powdered samples through stereo binocular microscope, Dr. Vinay Nikam for the kind courtesy in going through the text and by giving good and valuable suggestions and Mr. Chandrakant Mali for handling all the computer work.

6. REFERENCES

[1] Nandy N.C. and Deo V.B. – Origin of the Lonar Lake and Its Alkalinity –TISCO Vol. 8 No.3 (1961).
[2] Son T. H. and Koeberl C. – Chemical Variation in Lonar impact glasses and impactites – GFF vol. 129 (2007).
[3] Maloof A.C., Stewart S. T., Weiss B.P., Soule S. A., Swanson-Hysell N.L., Louzada K.L., Garrick-Bethell I., and Poussart P.M. – Geology of Lonar Crater, India GSA Bulletin (2010).
[4] Lafond E.C. and Dietz R.S. Lonar Crater, India, a meteorite Crater– Meteoritics, vol. 2, No.2 (1964).
[5] Jourdan F., Moynier F., Koeberl C. – First $^{40}Ar/^{39}Ar$ Age of the Lonar Crater: A ~0.65 Ma Impact Event? 41st Lunar and Planetary Science Conference (2010)
[6] Shinde V.A. and More S.M. – Study of Physicochemical Characterization of Lonar Lake Effecting Biodiversity Lonar Lake, Maharashtra, India, International Research Journal of Environment Sciences Vol. 2 (12), (2013).
[7] Gaikwad R.W. and Sasane V.V.- Assessment of groundwater quality in and around Lonar lake and possible water treatment – International Journal of Environment Sciences Vol. 3, No. 4. (2013).
[8] Pawar A.L. – Seasonal Variation in Physicochemical quality of Lonar Lake water-Journal of Chemical and Pharmaceutical Research 2(4): 225-231(2010).
[9] Komatsu G., Kumar P.S., Goto K., Sekine Y., Giri C., Matsui T.- Drainage systems of Lonar Crater, India: Contributions to Lonar Lake hydrology and crater degradation – Planetary and Space Science 95 (2014).
[10] Hagerty J.J., Newsom H.E. Hydrothermal alteration at the Lonar Lake impact structure, India implications for impact cratering on Mars – Meteoritics & Planetary Science, vol. 38, No. 3 (2003).
[11] Newsom H.E., Misra S., Wright S.P., and Muttik N.- Contrasting Alternation and Enrichment of Mobile Elements during weathering of Basaltic ejecta and ancient soils at Lonar crater, India – 41st Lunar and Planetary Science Conference (2010).
[12] Kumar P.S.- Structural effects of a meteorite impact on basalt: Evidence from Lonar crater, India – Journal of Geophysical Research, vol. 110 (2005).
[13] Chakrabarti R., Basu A.R.- Trace element and isotopic evidence for Archean basement in the Lonar crater impact breccias, Deccan Volcanic Province – Earth and Planetary Science 247 (2006).
[14] Morgan J.W.- Lonar crater glasses and high-magnesium australites: Trace element volatilization and meteoritic contamination – Proc. Lunar Planetary Sci. Con. 9th (1978).
[15] Stroube W.B., Jr., Garg A.N. Ali M.Z., and Ehmann W.D. A Chemical study of the impact glasses and basalts from Lonar crater, India – Meteoritics, vol.13, No. 2 (1978).

[16] Nayak V.K.- Maskelynite from the Indian impact Crater at Lonar – Journal Geological Society of India vol. 41 (1993).
[17] Sarkar P.K., Upasani D.V., Jadhav P.B. and Kowalkar P. – Study of the cavity filling Quartz Grains from the Ejecta Blanket at Lonar, Buldhana District, Maharashtra, India: An Evidence of Meteoric Impact – International Research journal of Earth Sciences, vol 2(10), (2914).
[18] Misra S., Newsom H.E., Shyam Prasad M., Geissman J.W., Dube A., and Sengupta Debashish. – Geochemical identification of impactor for Lonar crater, India – Meteoritics & Planetary Science 44 (2009).
[19] Murali A.V., Zolensky M.E., Sommer M.A. and Blanchard D.P.- Tektite-like Bodies at Lonar Crater, India: Implications for the origin of Tektites –Journal of Geophysical Research vol. 92, issue B4 (1987).
[20] Wright S.P., Johnson J.R., and Christensen P.R. - Thermal Emission Spectra of impact glass and shocked Deccan basalt from Lonar crater, India and implications for remote sensing of Mars – Lunar and Planetary Science xxxv (2004).
[21] Rajasekhar R.P. and Misra D.C. – Analysis of gravity and magnetic anomalies over Lonar lake, India: An impact crater in a basalt province – Current Science, vol. 88, No.11 (2005).
[22] Kraft M.D., Sharp T.G., and Michalski J.R.- Thermal Emission specta of silica-coated basalt and considerations for Martian surface Mineralogy– Lunar and Planetary Science xxxiv (2003).
[23] Chemtob S.M.- The origin and evolution of amorphous silica coatings on young Hawaiian basalts-California Institute of Technology (2013) pg II-1-III- 51.
[24] Badve R. M., Kumaran K.P.N., and Rajashekhar C.-Eutrophication of Lonar Lake, Maharashtra – Current Science , vol. 65 No. 4 (1993).
[25] Vyas P. P. Sarvanga Parichay: Jagprasiddha Vivar:Lonar – Sanskruti Prakashan, Aurad Shajani (2000).

APPENDIX

Table 1: Analysis of white rusting/white coating of silica scraped from basaltic rocks of Lonar lake by XRF. Sample 1

S. No.	Elements	Mass %	Oxides	Oxides Content	Mass (%)
1	Silicon	93.48	SiO_2	95.374	44.578
2	Sulphur	2.65	SO_3	1.991	0.997
3	Iron	2.09	Fe_2O_3	0.834	0.583
4	Aluminium	1.42	Al_2O_3	1.649	0.873
5	Calcium	0.25	CaO	0.1	0.071
6	Chromium	0.12	Cr_2O_3	0.051	0.035
7			Oxygen		52.863
	Total	100.01		99.999	100

Table 2: Analysis of white rusting/white coating of silica scraped from basaltic rocks of Lonar lake by XRF. Sample no.2

S. No	Elements	Mass %	Oxides	Oxides Content	Mass (%)
1	Silicon	95.31	SiO_2	97.24	45.45
2	Sulphur	2.67	SO_3	1.963	0.983
3	Iron	1.6	Fe_2O_3	0.624	0.436
4	Manganese	0.03	MnO	0.009	0.006
5	Calcium	0.19	CaO	0.075	0.054
6	Chromium	0.22	Cr_2O_3	0.088	0.06
7			Oxygen		53.011
	Total	100.02		99.999	100

Table 3: Analysis of white rusting part encapsulated on basaltic rocks of Lonar Lake by XRF. Sample No. 1

S. No.	Elements	Result	Unit	Oxides	Result	Unit
1	Silicon	98.9	mass %	SiO_2	99.4	mass %
2	Calcium	0.365	mass %	CaO	0.113	mass %
3	Aluminium	0.332	mass %	Al_2O_3	0.413	mass %
4	Iron	0.329	mass %	Fe_2O_3	0.097	mass %
5	Zinc	0.0303	mass %	ZnO	0.0076	mass %
6	Copper	0.0132	mass %	CuO	0.0034	mass %
7	Lead	0.002	mass %	PbO	0.0005	mass %
	Total	99.9715			100.0345	

Table 4 Analysis of white rusting part encapsulated on the basaltic rock of Lonar Lake by XRF. Sample 2.

S. No.	Elements	Result	Unit	Oxides	Result	Unit
1	Silicon	99.3	mass %	SiO_2	99.5	mass %
2	Aluminium	0.281	mass %	Al_2O_3	0.329	mass %
3	Calcium	0.194	mass %	CaO	0.0747	mass %
4	Iron	0.204	mass %	Fe_2O_3	0.0772	mass %
5	Zinc	0.0206	mass %	ZnO	0.0068	mass %
6	Copper	0.0096	mass %	CuO	0.0031	mass %
7	Lead	0.0014	mass %	PbO	0.0004	mass %
	Total	100.011		Total	99.9912	

Fig. 1: White rusting /white coating of silica on at Crater Lake, Lonar

Fig. 2: White rusting/white coating of silica on basaltic rocks basaltic rocks at Crater Lake, Lonar

Fig. 3: White rusting of silica seen on the rocks at Lake basin, Lonar

Fig. 4: White rusting of silica seen on rocks at Lonar Lake

Fig. 5: White rusting of silica seen on the stones of Ruined temples at the crater lake, Lonar

Fig. 6: White rusting of rocks on south side of the lake basin, Lonar crater lake

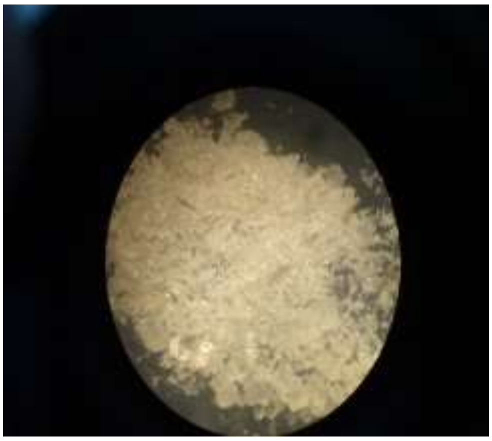

Fig. 7: The powdered form of white rusting showing amorphous Silica of Lonar crater lake observed under binocular microscope

Fig. 8: White rusting seen on a rock and also on the insect at Lonar Crater Lake

Fig. 9: A heap of rocks covered by white rusting at Crater Lake, Lonar

Fig. 10: White rusting seen on the stems of trees and bushes and branches and twigs at Lonar crater

Fig. 11: White rusting seen on the branches and twigs of bushes at Lonar crater lake

.

