Lonar Meteoritic Crater

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[[Lonar]] crater is an impact crater Located in the Buldhana district of [[Maharashtra]] State, [[India]] (190 58' N, 760 31' E)

Lonar crater is an important geological structure. This crater formed in basalt rock of the [[Deccan plateau]] some 35 to 50 thousand years is only of its kind. Though now it is declared as an impact crater, from 1823 when J. E. Alexander pointed out the crater, for almost a century and half the exact type of its origin was a debatable issue. Initially it was thought to be a volcanic crater. In fact, the famous geologist G.K. Gilbert in 1896 showed its similarity with the Meteor crater (Barringer crater), Arizona.

Though the Lonar crater does not have an adventurous scientific battle associated with it like the Arizona's [[Meteor Crater]], the crater itself is an interesting one and has been doubted as a [[volcanic]] crater for most of the nineteenth and half of the twentieth century. In 1896, the scientific patriarch G.K. Gilbert pointed out its similarity with the [[Meteor Crater]] but he rejected the impact origin of these craters. There were a few studies after but none suggested an impact origin. In 1952 C.A.Cotton in his monographic work entitled as 'Volcanoes as landscaped forms' doubted volcanic origin because of lack of recent volcanic process in Indian sub-continent and thus preferred meteoritic origin for Lonar crater. So a debate started: is Lonar crater an astrobleme or a geobleme?

[[Astrobleme]] is a scar on Earth created by a non-terrestrial entity while geobleme is a geological structure formed by the terrestrial process on the Earth itself. In 1961 N.C. Nandy and V.B. Deo made a thorough survey of the crater site. They suggested that a crypto-volcanic explosion must be responsible for crater-formation. Usually [[volcanic]] explosions are associated with extrusion of lava i.e. the molten interior of the Earth and also with the presence of [[pyroclastic]] material. On rare occasions there can be a violent explosion caused by steam accumulated under the ground without effusion of lava or formation of [[pyroclastic]] material. Since these two indicators were absent from the Lonar site crypto-volcanic process was suggested for its origin. Also the crater is situated on the [[Deccan plateau]] which is famous for its [[volcanic]] origin. Thus one might at first relate similar process for the crater. Nandy and Deo also suggested that the crater be formed shortly after the [[Cretaceous]] period i.e. 60 million years ago.

In 1964, Eugene C. Lafond conducted a field survey at Lonar and along with Robert S. Dietz suggested that the crater must have been an impact crater and originated some 50 thousand years ago. What was the basis for this suggestion? First of all they found that the crater is highly circular in diameter and has a characteristic depth-to diameter ratio of an impact crater. The crater has a raised rim, about 20m above the surrounding. This was another factor pointing towards the impact origin. The surrounding rock dips away from the crater edge at inclinations of 14-27 degrees, one more feature of [[impact craters]]. Along with such morphological parameters shock metamorphosis in the rock also tell how the crater is formed. To look at the rocks drilling into the crater was done. In the drilling done by Nandy and Deo [[breccia]] was found. [[Breccia]] is another feature of shocked rocks found in impact craters. Thus all these factors were pointing towards impact origin of Lonar crater. Lafond and Dietz also looked at the erosion of the crater site. Longer a site exposed to eroding entities such as wind, water, and temperature more it erodes or degrades and exposes underlying layers of soil. A geologist can look at these features and estimate age of the site. Lonar crater has been exposed to the eroding entities. It has a fresh water stream running in that erodes the walls, puts sediments onto the crater floor. Based on the erosion study and sediment accumulated in the crater Lafond and Dietz suggested that crater to be quite young. And it must be formed some 50 thousand years ago or at the most in late [[Pliocene]] i.e. 1.8 million years ago. The idea of impact origin then became even stronger when V.K. Nayak of Centre for Advanced Study in Geology, University of Saugar, Madhya Pradesh, India found glassy objects at the crater site. He found glassy objects

varying from 1mm to 5 cm that can be formed by melting and fusion of rock during an impact. In the drilled out material he found [[breccia]] with shocked features, broken and twisted [[plagioclase]], [[feldspars]], strongly oxidised [[basalt]]. All these are the features of shock metamorphosis associated with the rock that receives an hypervelocity impact.

In 1973, based on the work done by K. Fredriksson of [[Smithsonian Institution]], Washington DC, D.J. Milton of US Geological Survey, California in collaboration with A. Dube and MS Balasundaram of Geological Survey of India impact origin of Lonar crater was established. They discovered breccia with shatter cones and material containing maskelynite. Maskelynite formation requires very high pressure almost 4 lakh times the average atmospheric pressure on the Earth. And this is created only during hypervelocity impact. No volcanic process can form maskelynite. Thus impact origin of Lonar crater was proved. Three other researchers, D.Lal, D. MacDougall, and L. Wilkeing, estimated the age of the crater to be less than 50 thousand years using a [[fission-track dating]] method. Then, in 1996, based on properties of impact glasses found at the crater site D. Sengupta estimated age of Lonar crater to be about 52,000 years. Further more Fredriksson et al found that geological material of Lonar crater is very similar to the samples of rock brought from impact basins created on basalt surface of the Moon. This factor and uniqueness of Lonar crater being the only impact crater on the Earth in basalt rock make it an important structure for study of craters in the solar system. This is the prime reason for conserving the crater, which seem to have been neglected by our community in spite of the unique features of the crater.

Geo-morphology of Lonar crater: The crater is formed in the basalt rock of thickness 600-700m. This rock is made of many layers or flows which were laid why volcanic activity at various times, five of such flows are exposed at the crater rim. Thickness of these flows ranges from 5 to 30m. The crater is about 150m deep and has average diameter of 1830m. The elevated rim consists of 25m of bedrock and 5m of ejecta over it. This ejecta blanket is spread over about 1350m away from the crater rim and slopes away by 2-6 degrees. The uppermost region of ejecta contains the deposits that were melted due to the impact. Ejecta of any crater is an important factor. The way in which ejecta is spread tells about angle of impact. Spreading pattern for ejecta talks about degree of fluidisation of the rock, volatile components of the rock. This pattern also depends on the planet gravity and presence or absence of atmosphere. Thus if we know how these parameters effect spreading of ejecta then we can conclude about the conditions of impact on that particular planet. And the best place to know these parameters is our earth itself. However, hardly a few craters on the earth are studied well with reference to this point. Lonar crater has surprisingly well-preserved ejecta. Thus, this ejecta should be studied further and then it should be conserved also. Crater floor is almost flat harbours a shallow saline lake.