The Lakangaon eucrite: a unique, non-cumulate piece of rock from the Vesta

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Introduction: The HED (Howardite, Eucrite, Diogenite) meteorites are thought to have originated from a common differentiated parent body Asteroid 4-Vesta. The 4-Vesta represents one of the largest celestial bodies in the main asteroid belt and suggested the earliest stages of basaltic volcanism in the Solar System. The genetic link of the HED meteorite clan with asteroid 4-Vesta was established based on the similarity of petrological and spectral characteristics and the Vesta-HED connection was further consolidated by the recent Dawn mission. The eucrite is known for its typical basaltic texture similar to the terrestrial basalts. The Lakangaon eucrite fell on Nov 14, 1910, in the Nimar region of British India, near present-day Khandwa district, Madhya Pradesh, India, and is one of 261 approved meteorites classified as Eucrite-monomict as of date (Met. Bulletin). Lakangaon is a lesser-known eucrite as compared to other known Indian eucrites; hence it has not drawn much attention. Lakangaon was deemed the most Fe-rich eucrite [1], perhaps because it crystallised later than most Eucrites. Though the Lakangaon was described as Fe-rich eucrite in literature, detailed petrography and mineral chemistry were never discussed and explored in detail. Integrated mineral phase and whole-rock chemistry are always key in order to understand magmatic crystallisation event, identification of igneous processes of parent body and to constrain the thermal and chemical evolution of 4 Vesta. Hence, we discuss some new findings of petrochemistry of Lakangaon eucrite.

Methodology: This study was carried out using two polished thick sections of the Lakangaon sample. All petrographic characterisation, textural observation, BSE imaging, and data collection were performed using an FE-EPMA (model JEOL 8530F, Japan) equipped with EDS and five WDS. The minerals were analysed, and the images were taken using a typical accelerating voltage of 15keV and 15 nA sample current and beam size of 1μm. Natural and synthetic mineral standards were used for calibration. The peak counting time of the majority of elements was kept at 10s with the background of 5s (except for Na and K, it was 7s). The whole-rock trace element analyses were determined using a Q-ICPMS by ThermoFisher. BHVO2 was used for calibration. The accuracy of the analyses is better than 10%.

Mineral chemistry and whole-rock chemistry: Lakangaon, a brecciated basaltic eucrite, is dominated by mafic pyroxene and felsic plagioclase grains. Other accessory minerals include quartz, ilmenite, chromite, and troilite. The overall mineral modes of the sample include 36% pyroxene, 59.4% plagioclase + silica, and the accessory minerals like ilmenite, Mg-Al chromite, and troilite make up 0.9%. The pyroxenes composition ranges from ferrosilite to pigeonite to augite. The compositional trend of pyroxene is linear. Pigeonite primarily occurs as exsolution lamellae within the ferrosilite as well as in augite. Takeda and Graham [2] defined six types of eucrites, where type 1 is a pristine basalt which has suffered very limited subsequent metamorphism, while type 6 has been reheated and extensively metamorphosed. According to this analysis, Lakangaon falls in type 5 eucrite. The type 5 eucrites contain exsolved pigeonites with homogeneous host composition.

Troilite was pure FeS, with Cr, Co and, Ni below the detection limit. For plagioclase, only pyroxenes have been detected to be small inclusions. Clouding in pyroxene and plagioclase has been interpreted to be the result of the exsolution of minor components which became