MALOTAS (B) – A HIDDEN EUCRITE FROM A POLYMICT FALL?

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Introduction: We present the first petro-chemical and isotope data of the recently (re-) discovered Malotas (b) meteorite that belongs to the howardite-eucrite-diogenite (HED) clan of meteorites. This meteorite has been found together with two other meteorites - the Malotas H5 and the newly classified Malotas (c) L5 ordinary chondrites shortly after a bright fireball observed in the night of June 22nd, 1931, in Argentina [1]. Therefore, Malotas (b) has been classified as douptful meteorite fall. Until this study, Malotas (b) was a "hidden" unidentified achondrite, exhibited at the Museo de Mineralogía y Geología Dr. Alfred Stelzner in Cordoba City, Argentina.

Results and Discussion: Petrological, chemical and isotopic analysis of this rock revealed that Malotas (b) is a monomict, basaltic eucrite. This single stone with a mass of about 62 g is fully encrusted with a black shiny fusion crust and its light gray interior matrix appears fresh, with two different lithologies (i.e., coarse-and fine-grained). As typical for basaltic eucrites, it is mainly composed of exsolved pyroxene and plagioclase with minor Ti-oxides, sulfides, SiO_2 polymorphs, Ca-phosphates (apatite and merrillite) and rare zircon. One melt vein penetrating throughout the sample, undulatory extinction of plagioclase, the presence of abundant fractures and the monomict character of the sample indicate brecciation and shock metamorphism.

Oxygen isotopes of Malotas (b) are (in ‰): $\delta^{17}O_{VSSMOW}$ of 1.746 ± 0.006 and 1.736 ± 0.009; $\delta^{18}O_{VSSMOW}$ of 3.779 ± 0.003 and 3.787 ± 0.005; $\Delta^{17}O_{TFL}$ of -0.208 ± 0.006 and -0.222 ± 0.007. Bulk rock chemical composition revealed (i) a Mg# of ~38, (ii) FeO_t/MgO values of ~2.8 and ~2.9 for the fine-and coarse-grained lithologies, respectively, (iii) rare earth element concentrations of about 20× CI with a marked negative Eu anomaly, and (iv) enrichments in La, Th, U, Ti etc., indicating that the sample belongs to the chemical group of Stannern-trend eucrites [1]. According to [2] Malotas (b) can be classified as petrologic type 4 eucrite with geothermometry applied on pyroxenes revealing equilibration temperatures ranging between 700-805 °C. Exsolution lamellae in pyroxene also indicate thermal metamorphism and thermal annealing before a late thermal event took place after brecciation. Such a late thermal event is consistent with the variations found in the nominal gas-retention ages determined on a total of six aliquots of the three Malotas samples. While the U/Th-^{4}He ages are in the range 1.2 to 3.4 Ga, and scatter widely, which is consistent with late-stage partial resetting, the typically more retentive K-Ar system shows old ages in the range 3.5 to 4.2 Ga, respectively. The latter is consistent with resetting during the time period of the Late Heavy Bombardement.

In addition, the presence of anorthitic plagioclase veins in large clinopyroxene grains, veinlet F-apatite, irregularly-shaped pockets of silica and troilite and porous silica reveal that a metasomatic reaction took place. Different cosmic-ray exposure ages from ^{21}Ne of 3, ~50 and 27 Ma determined for the Malotas H5 and Malotas (c) L5 chondrites and the Malotas (b) eucrite, respectively, appears to prove that the samples come from different meteoroids. However, impact gardening of asteroidal regoliths leads to an efficient mixing that can result in variable cosmic ray exposure of rocks that are contained in the same meteoroid (e.g. [3]). Thus, the distinct cosmic ray exposure ages might be consistent with a common fall as a result of the breakup of a polymict carrier, as also suggested for the Fayetteville H4 chondrite [4] and the Almahata Sitta polymict anomalous ureilite [5,6].

Conclusion: Malotas (b) is a new member of the basaltic, monomict and metamorphosed Stannern-trend eucrites. Evidences of secondary metasomatism affecting the sample, in line with a growing number of metasomatized HED samples (e.g., [7]), further indicate a more widespead vapour and/or fluid-rock interaction on the eucrite parent body. Despite the very different cosmic-ray exposure ages of the three investigated samples, we cannot rule out that the three collected samples on the same site could be delivered to Earth in the same, polymict carrier body. Thus, our study contributes to the topical discussion of polymict meteoroid entries on Earth.

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