SECONDARY ALTERATION OF THE SERRA PELADA EUCRITE.

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Introduction: In this study, the petrology of the observed meteorite fall Serra Pelada from Brazil has been investigated with a focus on secondary alteration features of this meteorite that form by shock- and thermal-metamorphic reactions and probably even fluid-rock interactions. Such complex crustal processes on rocky asteroidal bodies in the inner Solar System are abundant but yet not well understood. As the Serra Pelada meteorite exhibit a variety of secondary alteration features, this sample has been selected for this case study.

Results and Discussion: The Serra Pelada meteorite fell on June 29th 2017, weighing 12 kg total and has been classified as a monomict eucrite. Here, two polished sections (O336 and O338, inventory NHM Vienna) were investigated using the optical and electron microscope facility at the NHM Vienna, Austria. Results confirm that Serra Pelada is a moderately shocked monomict basaltic eucrite. This sample displays a brecciated texture composed of various lithic clast types embedded in a fine-grained silicate matrix, mainly consisting of pyroxene and plagioclase. The lithic clasts are typically ophitic to subophitic, and some exhibit evidence of recrystallization. In addition, some rounded clasts occur as inclusions in large orthopyroxene mineral fragments.

Shock features include undulatory extinction and mosaicism of silicates, the occurrence of melt pockets and impact melt veins cross-cutting the sample, and the absence of maskelynite, confirming the moderate degree of shock metamorphism. In addition to rock-forming silicates, accessory minerals are present in Serra Pelada, as typically found in other basaltic eucrites, including: silica, ilmenite, chromite, troilite, and (low Ni-) Fe-metal. In addition, F-apatite, merrillite, zircon and baddeleyite, and (secondary) Fe-rich olivine veinlets within larger pyroxene grains are present. The Ca-phosphates are often fractured and occur interstitial to plagioclase, low- and high-Ca-pyroxenes and often in mineral assemblages with troilite, chromite and ilmenite. Some Ca-phosphate grains are located within lithic clasts and here often in association with silica and rare zircon. Replacement reactions of merrillite and F-apatite are observed, again indicative of a thermal-metamorphic reaction affecting the host rock. Zircon grains are subrounded and up to 20 μm in size, often fractured, and typically enclosed in or exsolved from ilmenite and in association with merrillite. This petrological finding can be assigned to thermal metamorphism, and has been used together with radioisotope analysis to constraint the timing of a global crustal metamorphic event on the eucrite parent body(ies) [e.g., 1]. A lithic clast of ~60 μm in size and composed of silica, plagioclase and orthopyroxene, located at the margin of a large ~500 μm ilmenite grain, is surrounded by a ~5 μm zircon rim. This rim is composed of aligned individual zircon grains that likely formed by a thermal-metamorphic reaction in the Serra Pelada eucrite.

In addition, chromite and ilmenite grains are often intergrown, which seems typical for highly metamorphosed (type 5 and 6) eucrites [2], and which is petrologically consistent with the presence of coarse augite exsolution lamellae within pigeonite hosts and extensive replacement of pigeonite by augite. Two lithic clasts with a fine-grained, recrystallized texture, mainly composed of Ca-pyroxene and silica grains of <20 μm each, also contain larger chromite and ilmenite grains of up to 200 μm in size, which are located along the margins. Within these two clasts finely dispersed troilite, F-apatite and chromite grains of <10 μm are present in addition that likely crystallized upon intense thermal metamorphism.

The Fe-rich olivine veinlets are always associated with coarse pyroxene grains in the silicate matrix or large pyroxene grains within lithic clasts (i.e., absent in plagioclase). They formed as a trail of individual olivine grains, which are accompanied by anorthitic plagioclase, chromite and troilite grains. The finding of such Fe-rich olivine veinlets is interpret to form during secondary alteration processes, either related to metasomatic, shock- or thermal-metamorphic origin and/or a combination of those processes. These petrologic features were discovered and discussed in a limited number of eucrite and howardite samples so far, e.g. [3-7].

Conclusions: The moderately shocked, monomict basaltic eucrite Serra Pelada is characterized by the occurrence of lithic clasts with various textures and a series of shock- and thermal-metamorphic and probably even metasomatic features. Observed secondary alteration processes not only affect the rock-forming silicate textures, but are prominently recorded in the petrology of accessory phases, such as in spinels, zircon and Ca-phosphates grains in particular, further supporting their relevance for the interpretation of large-scale metamorphic processes on meteorite parent bodies.

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