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PETROGRAPHIC AND GEOCHEMICAL STUDY OF AN ANOMALOUS MELT ROCK FROM THE GILF KEBIR PLATEAU, CLOSE TO THE LIBYAN DESERT GLASS AREA, EGYPT

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Introduction: Four of the authors (D. B., R. L., B. D., and P. V.) collected unusual samples from a meter-sized boulder found among tabular formations of sandstone in the north of the Gilf Kebir plateau, Egypt, about 160 km south-southeast of the Libyan desert glass (LDG) area.

LDG is a natural silica glass found in between sand dunes of the Great Sand Sea of western Egypt [1]. Although its origin has been the subject of much debate, LDG is now generally recognized as an impact product [e.g., 2]. However, no impact crater has so far been found in the LDG area.

For this study, the samples were investigated using optical microscope, microRaman, SEM, microprobe, ICP-AES, and ICP-MS.

Results: The rock is dark gray in color, very compact (i.e., no vesicles), and strongly magnetic. Whole rock analyses are as follow (in wt%): SiO_2 40.5; Al_2O_3 30.8, Fe_2O_3 22.7, TiO_2 4.4, with remarkably low alkali ($Na_2O + K_2O$ = 0.1 wt%) and CaO (0.1 wt%) contents. In thin section, the rock displays a magmatic aphanitic-microlitic texture with microlites of mullite ($Al_{4.2}Fe^{3+}_{0.2}Si_{1.6}O_{9.8}$), an Fe-rich spinel close to magnetite, and an Fe-Ti oxide, in a mesostasis of nearly pure silica. Tridymite has been identified in the mesostasis, as well as in segregation veinlets. Rounded, relict quartz grains also occur and are surrounded by tridymite. Platinum group element (PGE) concentrations in the melt rock are within the range of the average continental crust with iridium as an exception, slightly more elevated. These PGE patterns are similar to those measured for LDG.

Discussion: This melt rock has a composition and mineralogy that is, to our knowledge, unreported from any terrestrial magmatic rock. Phase diagrams in the system SiO_2-Al_2O_3-FeO-Fe_2O_3 suggest that temperature c. 1600 °C is needed to melt a rock with such a composition. Considering the location of recovery, and the lack of vesicles, an anthropogenic origin is highly unlikely. The PGE signature of the melt rock is neither diagnostic of an impact origin, nor the contrary, as is also the case for the PGEs in LDG. Although the chemical composition of the rock and the high-temperature involved in its formation seem to be pointing to an impact origin, no high pressure phases have so far been detected.

Acknowledgments: This abstract is dedicated to the memory of Edmond Diemer 1929–2008).

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P-T CONDITIONS AND MECHANISMS OF ENSTATITE TO AKIMOTOITE TRANSFORMATIONS IN THE SHOCKED L-6 CHONDRITE TENHAM

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Introduction: Our recent studies on the shocked L6 Tenham chondrite revealed different settings of enstatite to akimotoite conversion: (1) complete transformation of enstatite, (2) a lamellar setting mimicking intracrystalline transformation (3) coexistening akimotoite and pyroxene glass, the latter interpreted as amorphization product of former perovskite [1]. The recent report of fractional crystallization of high-pressure olivine liquid to ringwoodite and wadsleyite in chondrules entrained in a shock melt vein [2] motivated us to explore this possibility for pyroxenes in shock-melt veins in Tenham.

Results: We surveyed the different high-pressure assemblages in a shock melt vein as well as the transformations near the vein in Tenham. Three different forms of ringwoodite and akimotoite were encountered in the same settings: (1) a polycrystalline transformation presumably resulting from solid-state transformation, (2) lamellar intergrowth in the low pressure polymorph (3) a crystallization from melt. We also encountered lingunite at the vein wall. This assemblage of different high-pressure polymorphs records a shock pressure in the range of 19–24 GPa and around 2500 K

We conducted FIB cutting [3] for STEM study in two of the three akimotoite areas and we investigated the conversion mechanisms. In both cases, observations reveal that akimotoite formed from the crystallization of the high-pressure melt. They also suggest that the pyroxene melt is hardly miscible with the chondritic liquid. However, chemical analysis made by STEM-EDS on the akimotoite and enstatite revealed different chemical compositions. Akimotoite compositions distinct from that of enstatite resulted from interaction between melts. The "intracrystalline akimotoite" with the formula $(Ca_{0,01},Mg_{1,44},Fe_{0,57},Al_{0,02})$ $(Si_{1,88}, Al_{0,12})O_6$, is significantly different from the former pyroxene $(Ca_{0,03},Mg_{1,4},Fe_{0,64})(Si_{1,87}, Al_{0,13})O_6$ and hence did not emerge from solid-state inversion. The "bulk transformed area" has a chemical formula of $(Ca_{0,01},Mg_{1,64},Fe_{0,32},Al_{0,02})Si_2O_6$, different from the intracrystalline akimotoite and the enstatite. This would indicate melting, crystallization and elemental exchange reactions.

Conclusions: Our results confirm that shock melt veins, due to their menagerie of high-pressure minerals contain numerous reliable indicators for the P-T conditions in shocked meteorites and that entrainment of minerals inside the shock melt vein, particularly orthopyroxene, can lead to their partial melting followed by a high pressure crystallization and quenching, barely mixing with the adjacent material.

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