EXPERIMENTAL INVESTIGATION OF SHOCK EFFECTS IN A PELITIC GRANULITE – IMPLICATIONS FOR SHOCK MELT GENESIS.

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Introduction: Most experimental shock investigations to date have concentrated on monomineralic or relatively anhydrous rocks, such as quartzite or granite. In contrast, rocks of pelitic composition, which typically display a complex mineralogy and a high proportion of hydrous minerals, have been little studied. Shock experiments were performed on a fine-grained, high-grade, migmatitic, garnet-cordierite-biotite-orthopyroxene metapelite from the Etivé aureole, Scotland, to (1) characterise shock effects in a complex polymineralic rock with a significant proportion of hydrous ferromagnesian minerals, both as a function of variable shock pressure and pre-shock temperature, and (2) explore the effects of shock impedance contrast between component minerals on the distribution of these features. Shock experiments were performed at 12, 25, 30 and 60 GPa at 25 C, and at 25 GPa at 400 C. The association of plagioclase, K-feldspar and quartz in the assemblage facilitates comparison with previously calibrated systems [1].

Results: Shock features (planar fractures - PFs, fracture arrays, planar deformation elements - PDFs, onset of isotropization, formation of diaplectic glass, and shock melting) have been characterized and calibrated in cordierite, biotite, quartz, garnet, plagioclase, K-feldspar, orthopyroxene, ilmenite, and pyrite with respect to shock pressure and pre-shock temperature. Shock metamorphic effects are also influenced by the spatial association of minerals – higher-P shock effects appear locally within a sample where shock impedance contrast between adjacent minerals is greatest, such as between garnet, on the one side, and cordierite, feldspar or quartz. The experiments also provide some constraints on the shock metamorphic effects in the Steynskraal Formation metapelites in the Vredefort dome, South Africa. The heterogeneity of shock effects observed in the experiments, and the mobilization of biotite and cordierite shock melts appear to have analogues in the form of pseudotachylitic breccia veinlets and the occurrence of mobile potassic phases [2]. Petrographic and SEM investigation of the metapelites that contain mm-wide pseudotachylitic breccia veinlets suggest increasing intensity of shock effects in all component phases in the matrix toward the breccias. SEM and EDS analysis indicate a strong correlation between local melt compositions and immediately adjacent minerals, with multi-component mixing becoming more pronounced in thicker veins. Biotite, cordierite and feldspar are the major contributing phases to the melts. These features are consistent with locally enhanced (cm- to mm-scale) shock effects in excess of 30 GPa in rocks that display shock P effects that are more consistent with background pressures of 15-20 GPa. This enhancement is attributed to refraction and/or reflection of the impact shock wave in the heterogeneous target lithologies.

References: [1] B. French (1998). LPI Contr. No. 954, LPI, Houston, 120pp. [2] R.L. Gibson (2002). J. met. Geol., 20, 57-70.