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Origin of melt heterogeneities in Ries impact breccia

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Abstract

New detailed textural and chemical investigation of melt-bearing impact breccias (suevites) reveal that they contain three melt types which represent the sequence of successively decreasing shock pressure: whole-rock melting, partial melting of a certain volume of rocks, with variations of mixing of monomineralic melts. Trace element analysis of melts allow to distinguish between melts from different regions of the crater recording primary heterogeneities in the target. This improves our understanding of the origin and emplacement of melt-bearing impact breccias.

Introduction

Suevites in the Ries impact structure were in focus of many previous studies [7, and references therein]. In particular melt particle in suevite were used for genetic statements of the origin and emplacement of suevite, and for estimation of involved lithologies at impact melt formation. Despite noted heterogeneities at the sub-centimeter scale, the conclusions are very similar from homogeneous to nearly homogeneous in terms of major element composition [e.g., 6, 8] by melting of ca. 20% to 40% amphibolite and 60% to 80% granites [2, 4, 8]. This has been considered consistent with findings at other impact structures where impact melt often displays chemical homogeneity [1].

However, trace element studies have shown that there may be variabilities in impact melts [3]. The Ries suevite melt particles have been revisited in consideration of major and trace element chemistry. The results provide information about their origin and subsequent emplacement processes [5].

Results and Discussion

Three melt types have been identified based on petrographic, geochemical information, and degree of rock melting. The most common and volumetrically abundant melt is the whole rock melt 1.

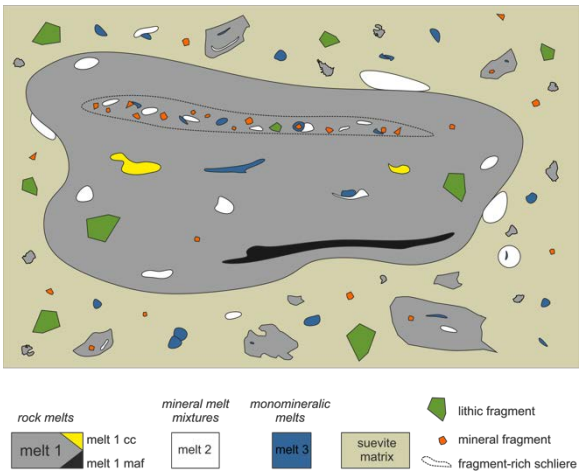

Figure 1: Sketch of suevite with identified melt types.

Characteristically are schlieren in melt 1 by mafic rock melts and occasionally occurring of in emulsion carbonate melts. Mineralic melt mixtures (melt 2) and monomineralic melts (melt 3) occurs attached to or within melt 1 particles or embedded in the suevite matrix (Fig. 1). Melt 1 types represents whole rock melting and therefore is much more homogeneous in composition than melt 2 and 3 (Fig. 2). Hydrothermal activity and/or weathering led to alteration of all melt types at many suevite deposits. Using isocon method show that there was significantly mass transfer in most major and many trace elements. However, the high field strength elements Zr, Nb, Hf, Th, Ta, V, and Ti were mostly immobile. These elements are most suitable to study the origin and emplacement of the impact melt-bearing breccias. Significant

differences exist mainly in trace element composition between melt 1 particles of suevite locations in the East and West of the crater. This reflects probing of chemically different target lithologies during cratering [5]. The consideration of trace elements and the separate evaluation of melts from suevite from two different regions of the crater allow a more precise estimation of the relative amount of various crystalline basement rocks involved in the formation of the major melt particles (melt 1). In the western area gneisses and granitoids represent 91%, schist 1%, and mafic rocks 8%. In the eastern area gneisses and granitoids represent 89%, schist 3%, and mafic rocks 8%.

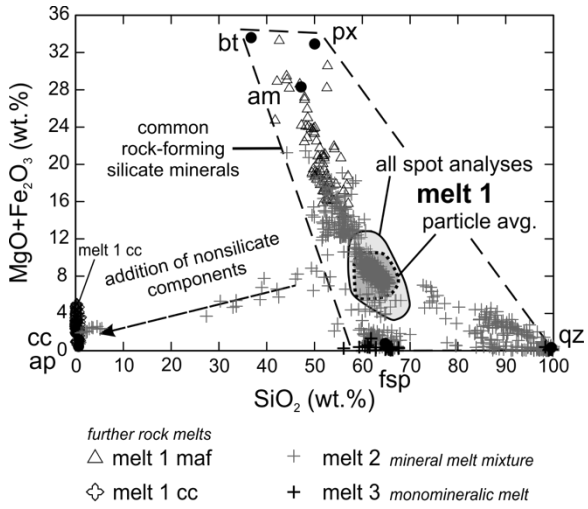

Figure 2: Major element geochemistry of melt types.

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