

RESORBED ANDRADITE GARNET IN THE LOWER YAXCOPOIL-1 IMPACT MELT BRECCIA: EVIDENCE FOR HYDROTHERMAL PROCESSES AT T>300°C

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Introduction: The Yax-1 bore hole of the Chicxulub crater recovered at 794–895 m a continuous section of impactites consisting of suevites and brecciated melt rocks. The impact melt breccia at Unit 5 at 861.72 m contains melt clasts which are fragmented in a puzzle piece relationship cross cut by a matrix of Mg-Al-rich clays with CaCO₃. The matrix displays K-metasomatism and halite (NaCl) crystallization. The recent discovery of andradite garnet in the matrix [1] is motivation for a detailed microstructural study.

Methods: The impact melt breccia at Unit 5 at 861.72 m was studied by SEM with a Bruker QUANTAX EDS system equipped with silicon drift detector (SDD). A high resolution, element composite map (2 μm pixel resolution) of a sample area 15x11 mm in size was acquired by automated stage control within hours. Hyperspectral EDS databases of selected regions were acquired and evaluated. Point and line scan spectra of andradite garnet were quantified using reference standards.

Results: On a large scale, the rims of the melt clasts display a reaction zone with the matrix. When compared to the centre where TiO₂ precipitates are common, rims display a depletion of Ti and Fe but show a K-enrichment corresponding to the presence of adularia. The matrix contains local enrichments of Ti and Fe-oxides and andradite garnets up to 150 μm in size. Garnets show compositional variations in TiO₂ (Tab. 1) with Ti enrichment at the rim and various dissolution features. Replacement of garnets by matrix clay is associated with formation of Ti and Fe-oxides accompanied with halite. Other associated minerals are apatite with euhedral or deformed morphologies and elevated SO₃ concentrations (3–4 wt.%) which were previously reported by [2]. In veins between larger melt clasts, euhedral barite is observed in matrix clay.

Tab. 1 Composition (wt.%) of andradite garnet.

	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaO	Total
Mean (n=53)	34.0	3.71	4.40	24.2	0.74	31.8	98.9
s (±wt.%)	0.7	0.92	0.40	1.0	0.21	0.3	0.81

Discussion: The presence of hydrothermal andradite garnet has been observed before at the Manson impact structure suggesting fluid temperatures >300°C [3]. At Yax-1, the zoning and partial dissolution of garnets in the lower impact breccia reflects fluid evolution of T, pH, fO₂, X_{CO2} and salinity during and after formation, and confirms a high temperature stage of the hydrothermal system [eg. 3]. The element maps display evidence of leaching of Fe and Ti from the larger melt clasts. This process may be a source for enrichment of these elements in the matrix and garnets.

References: [1] Newsom H. E. et al. 2010. Abstract #1751. 41th Lunar & Planetary Science Conference. [2] Zürcher L., and Kring D. A. (2004) *MAPS*, 39, 1199-1222. [3] McCarville P. and Crossey L. J. (1996) *GSA special paper*, 302, 347-376.