**IMPACT MELT ROCKS FROM THE RIES IMPACT STRUCTURE, GERMANY: PRELIMINARY RESULTS OF AN ANALYTICAL SEM STUDY.** G. R. Osinski[1] and J. G. Spray[1], [1]Planetary and Space Science Centre, Dept. of Geology, University of New Brunswick, 2 Bailey Drive, Fredericton, NB, E3B 5A3, Canada (osinski@lycos.com).

**Introduction:** Impact melted materials occur in two main forms in the Ries impact structure [1]: (1) as isolated bodies of reddish, vesicular, fine-grained impact melt rock; (2) as individual glassy particles or clasts in melt-bearing breccias or suevites. The latter lithologies have been the subject of a considerable number of investigations over the past few decades. In contrast, no detailed investigations of the impact melt rocks have been published. Here, we present the preliminary results of an analytical scanning electron microscope (SEM) study of impact melt rocks from the Ries structure.

**The Ries impact structure:** The 24 km diameter 14.5 Ma old Ries impact structure is one of the best preserved complex impact structures on Earth. The target rocks consist of a flat-lying sequence of predominantly Mesozoic sedimentary rocks that unconformably overlie Hercynian crystalline basement. The sedimentary cover at the time of impact varied in thickness from ~470 m in the north to ~820 m in the south [2]. The structure possesses a sequence of impactites (impact-produced rocks), including a thick series of crater-fill rocks, various types of distal ejecta deposits (preserved up to ~37 km radius), and a tektite ('moldavite') strewn field extending out to distances of 260-400 km to the east of the Ries structure [3].

**Impact melt rocks:** Only two occurrences of impact melt rock *sensu stricto* have been documented at the Ries impact structure. These occur at Amerbach and Polsingen in the ENE of the structure and represent isolated bodies of impact melt rock with lateral extents <10-50 m [1]. They are seen to overlie Bunte breccia or megablocks [1]. Previous workers have described these lithologies as consisting of a reddish, vesicular, fine-grained recrystallized matrix of feldspar, celadonite, pyroxene and cristobalite [1, 4]. These rocks have also been termed (red) suevites by some workers [4, 5].

**Samples and analytical techniques:** Four samples from the Polsingen quarry were collected by GRO during two field expeditions (August 2000 and June 2001). The Amerbach road cuts are no longer exposed, however, three samples from the impact collection of the Geological Survey of Canada were examined. Polished thin sections were investigated using a JEOL 6400 digital scanning electron microscope (SEM) equipped with a Link Analytical eXL energy dispersive spectrometer (EDS) and Si(Li) LZ-4 Pentafet detector. Phase compositions were determined in EDS mode at count times of 100s, beam operating conditions of 15 kV and 2.5 nA, and at a working distance of 37 mm. SEM back-scattered electron (BSE) imaging was used to investigate the microtextures.

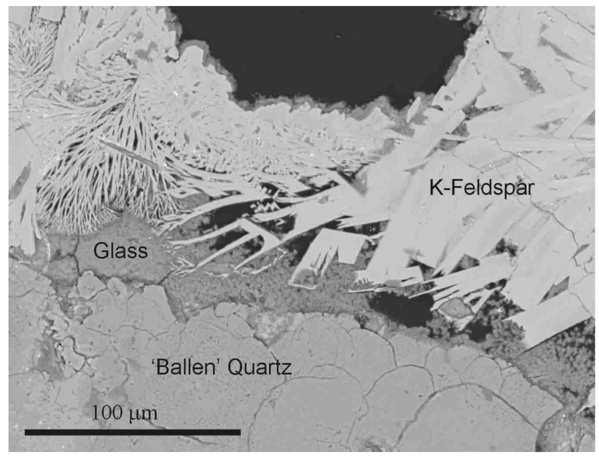


**Figure 1.** BSE SEM image of impact melt rock from Polsingen. Note the spectacular 'swallow tail' and dendritic terminations indicative of rapid crystallization from a melt.

**Results:** Impact melt rocks from Polsingen and Amerbach comprise a microscopic matrix containing variably shocked lithic (predominantly granite) and mineral clasts (predominantly quartz) (Fig. 1). It is notable that the majority of quartz fragments (>75%) display the so-called 'ballen' texture (Fig. 1). This distinctive texture is widely accepted to form from the inversion of lechatelierite during cooling [6].

SEM BSE imagery reveals that the microcrystalline matrix comprises K-feldspar, plagioclase and quartz (decreasing order of abundance) with interstices filled by either a fresh or devitrified glassy mesostasis (Fig. 1). Accessory minerals include hematite, ilmentite and rutile. No pyroxene or celadonite have been found in the samples studied. Skeletal laths of an unknown hydrous phase have been recognized. Further work is ongoing as to the nature of this material.

*Feldspars.* It is notable that the composition of feldspars can vary considerably, even between neighbouring crystallites, although K-feldspar predominates (Fig. 2). Several feldspars also display unusual Ternary compositions (Fig. 2). BSE imagery reveals that plagioclase and K-feldspar display a range of crystal habits and textures. These include (Fig. 1): (1) hollow, box-like crystallites; (2) single feathery dendritic crystallites; (3) acicular laths with hollow, 'swallow tail' terminations; (4) laths with dendritic terminations; (5) spherical, bow-tie, plumose, fan, and axiolitic spherulites. Skeletal and dendritic crystal forms are well understood quench crystal morphologies that indicate rapid crystallization from a melt [7, 8]. This occurs during quenching in response to high degrees of undercooling and supersaturation, and low nucleation densities [8]. Spherulitic textures are indicative of subsequent devitrification, that is, the nucleation and growth of crystals at subsolidus temperatures [7].

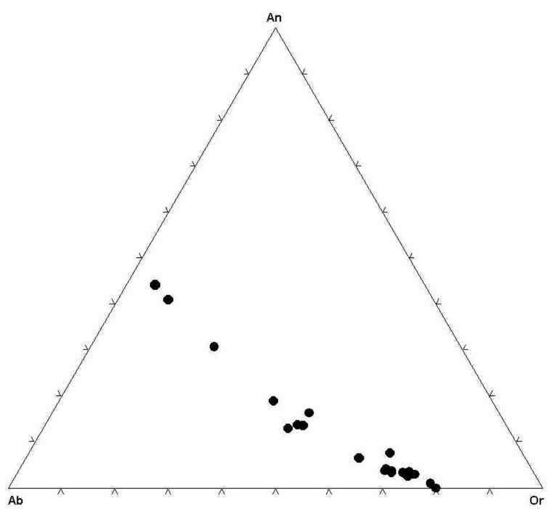


**Figure 2.** Anorthite (An), albite (Ab), orthoclase (Or) plots displaying the compositions of feldspar crystallites in impact melt rocks from Polsingen.

*Quartz.* This mineral forms a minor (~5-10 vol%) of the impact melt rocks. It occurs in two main forms: (1) as dendritic masses, typically seen to nucleate on quartz clasts; (2) irregular, anhedral intergrowths with K-feldspar. As noted previously, dendritic textures are characteristic of quenched melts.

*Mesostasis.* The interstices between crystallites comprise a fine-grained dark mesostasis that consists of either fresh or devitrified glass. The Al and Si content of this material varies dramatically from 57.7 wt% $SiO_2$ and 23 wt% $Al_2O_3$, to 11.0 wt% $SiO_2$ and 77.4 wt% $Al_2O_3$. In addition, this material contains FeO (0.4-12.6 wt%), MgO (0.5-3.1 wt%), CaO (0.0-1.3 wt%), and $K_2O$ (0.2-2.7 wt%). Oxide totals are typically ~79-91 % suggesting substantial volatile content.

**Discussion:** Feldspars within the impact melt rocks at Polsingen and Amerbach display skeletal and often acicular forms. These are well understood quench crystal morphologies and indicate rapid crystallization from a melt [7, 8]. Such features are common in impact melt rocks from other terrestrial craters [e.g., 6].

It is generally considered that the mode of deposition of these melt rocks was the same as the fallout suevites, that is, essentially airborne [e.g., 4]. However, this interpretation is hard to reconcile with the size (~50 m lateral extent) and coherent nature of these lithologies. We suggest that another possible mode of transport was that of an impact melt flow, emplaced outwards from the crater centre during the excavation stage of complex impact crater formation. Further work is planned to further characterize the melt rocks and to determine their mode of emplacement.

**Acknowledgments:** This work represents a component of the PhD thesis of GRO and was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) through research grants to JGS. Financial support for fieldwork at the Ries impact structure came from the Eugene Shoemaker Impact Cratering Award presented to GRO in November 2000. Gisela Pösges and Michael Schieber of the Rieskrater-museum, Nördlingen, are thanked for their help during fieldwork carried out by GRO.

**References:** [1] Pohl J. et al. (1977) In *Impact and Explosion Cratering* (eds. Roddy D. J. et al.), pp. 343-404. [2] Schmidt-Kaler H. (1978) In *Principle Exposures of the Ries Meteorite Crater in Southern Germany* (eds. Chao E. C. T. et al.), pp. 8-11. [3] Hörz F. (1982) *In Geological Implications of Impacts of Large Asteroids and Comets on the Earth* (eds. Silver L. T. et al.), pp. 39-55. [4] Englhardt W. v. and Graup G. (1984) *Geol. Rund.*, 73, 447-481. [5] Englhardt W. v. et al. (1969) *Geol. Bav.*, 61, 229-295. [6] Carstens H. (1975) *Contrib. Min. Pet.*, 50, 145-155. [7] Lofgren G. (1974) *Am. J. Sci.*, 274, 243-273. [8] Donaldson C. H. (1976) *Contrib. Min. Pet.*, 57, 187-213.