MELTING AT THE CONTACT BETWEEN IMPACT MELT AND HOST ROCKS: X-RAY CT AND SEM/EDS OF THE VREDEFORT GRANOPHYRE. M. S. Huber[1,2], E. Kovaleva[1,2], Fernandez, V.[3], and Salge, T.[3], [1]University of the Western Cape (Robert Sobukwe Rd., Cape Town, South Africa; mhuber@uwc.ac.za; ekovaleva@uwc.ac.za), [2]Zavaritsky Institute of Geology and Geochemistry, Ural Branch of the Russian Academy of Sciences, Ekaterinburg, Russia. [3]Imaging and Analysis Centre, Natural History Museum (Cromwell Road, SW7 5BD, London, United Kingdom; v.fernandez@nhm.ac.uk; t.salge@nhm.ac.uk).

Introduction: The 2.02 Ga Vredefort impact event [1] was among the largest impact events since the Archean, resulting in an impact structure that had an original diameter of up to 300 km [2]. The formation of the structure resulted in widespread melting of the target rocks, generating both *in situ* melt, known as pseudotachylites [3,4], and an impact melt sheet. Due to the ca. 10 km of erosion of the Vredefort structure since its formation [5,6], the melt sheet has been removed, and the only remnants of the melt sheet are dikes of impact melt known as the Vredefort Granophyre [7,8].

The Vredefort Granophyre has been linked to the melt sheet via bulk chemistry [8], trace element analysis [9], and geochemical modeling [10]. Recent work has shown that the Vredefort Granophyre was emplaced at high temperature with very low viscosity, with sufficient heat capacity to assimilate or melt the target rocks [11]. The degree to which assimilation could take place is uncertain. A systematic review of the studies on Vredefort Granophyre was recently conducted [12].

To test the assimilation of the host rock, a drill core sample of the exposed contact between the Vredefort Granophyre and the host granitoid was obtained. Non-destructive scanning electron microscopy (SEM) and energy-dispersive spectrometry (EDS) of the surface, combined with X-ray computed tomography (CT) of the interior of the sample, were obtained to provide insights into the processes taking place along the melt-host rock contact.

Methods: A drill core sample of the contact between the Vredefort Granophyre and the host granitoid was provided by Mr. Christo Meyer, owner of the Kopjeskraal Farm. The sample was originally drilled perpendicular to the surface in 2012 for geophysical analysis [13]. The sample is 9.6 cm in length and 3.3 cm in diameter. The sample was broken approximately at the midpoint and epoxied together prior to the analyses in this study.

The sample was analyzed geochemically by non-destructive, non-invasive SEM/EDS using a high-sensitivity, annular, four channel Bruker FlatQUAD EDS detector (inserted between the pole piece and sample) fitted to a variable pressure FEI Quanta 650 field emission SEM (6kV and 9kV, 20 Pa). This geometry allows sufficient data collection on uncoated samples with substantial surface topography.

The internal features were imaged using a Nikon XTH 225 ST X-ray micro-CT system with a static reflection tungsten target (160 kV, 125 µA, Cu 1 mm, 3142 projections, 708 msec exposure, 4 frame averaging).

Observations and Discussion: The exterior of the sample has a distinct contact between the Vredefort Granophyre, which is a fine-grained, dark-colored melt with sparse visible clasts of light-colored silicate minerals, and the host granitoid, which is light-pink and medium-grained.

The elemental mapping of the contact shows the interaction of the pyroxene-rich granophyre melt and the felsic basement granitoid (Fig. 1). The host rock is composed of quartz, feldspar, and biotite, with minor amounts of magnetite. The granophyre is composed predominantly of pyroxene and feldspar, with elongate, quenched crystals of pyroxene. Along the contact between the granophyre and host rock, an additional felsic melt phase is observed, which is immiscibly mingled with the granophyre, so that elongate strands of quartz-rich felsic melt extend into the mafic melt of granophyre. Additionally, the immediate contact between the host rock and Granophyre has a ca. 200 µm-thick interface that is enriched in quartz compared the host granite.

The CT data of the sample shows that similar features exist throughout the interface within the sample. Within the granophyre, the resolution of the images (20 µm/voxel) is sufficient to see individual pyroxene laths and the groundmass between laths, although with little detail. The interface between the host rock and granophyre is clearly visible as a planar surface, and dips at an angle of 66º from horizontal (Fig. 2). The interface is disrupted by zones of unmelted host rock that protrude by 1 cm into the melt. Between the host rock and granophyre is a zone of partial melting, wherein the textures are distinct from the main mass of granophyre (Fig. 2). Virtual cross-sections from the CT data show inundations of the Granophyre melt into the host rock, with thin stringers of Granophyre penetrating up to 1 cm into the host rocks, with apparent diameters of melt injections being ≤100 µm. Conversely, the felsic melt, sourced from the host rocks, extends across the entire measured extent of the granophyre

(Fig. 2). This felsic melt is highly enriched in quartz. In a virtual section, the melting of the granite and mobilization of the silica-rich melt into the granophyre is clearly visible (Fig. 3). The orientations of the melted silica enclaves are parallel to the drilling orientation, suggesting that the melt was moving vertically within the Granophyre melt.

The melting of the host rock is consistent with a high temperature of Granophyre emplacement, as previously suggested [10,11]. However, it is unclear if assimilation is taking place, because the granophyre apparently interacted immiscibly with the silica-rich partially melted granitoid phases, resulting in numerous enclaves and inclusions of quartz that are observed in the Granophyre [14] (Fig. 3). Mobilization of these partially melted enclaves may have been driven in party by devolatization of the host rocks, allowing for fluid escape veins to form in the Granophyre [15].

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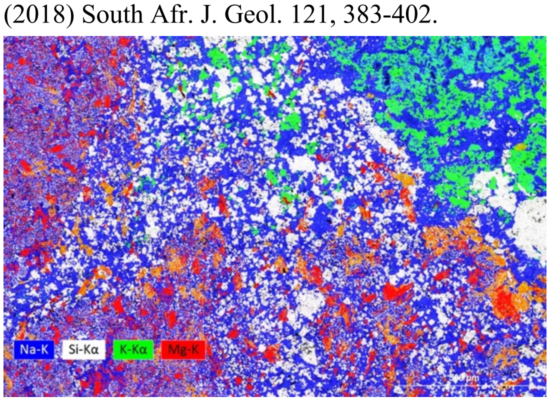

Fig. 1: Elemental map (9 kV, 1.35 µm pixel size) of the contact between granophyre and granitoid host rock. Note the immiscible mixing of quartz-rich melt and more mafic composition granophyre.

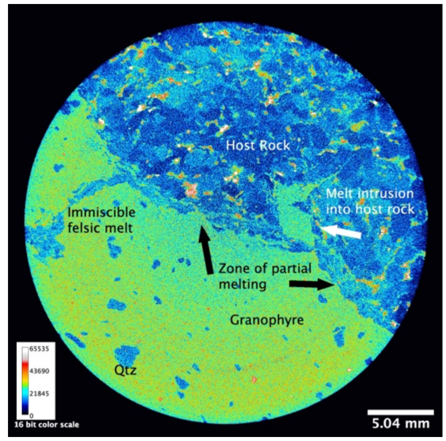

Fig. 2: Virtual section of CT scan showing interface between the granophyre melt (green) and the host rock (blue). The interface between the host rocks and melt features a zone of partial melting, where felsic melt is mingling with the granophyre. The granophyre also is intruding into the host rock.

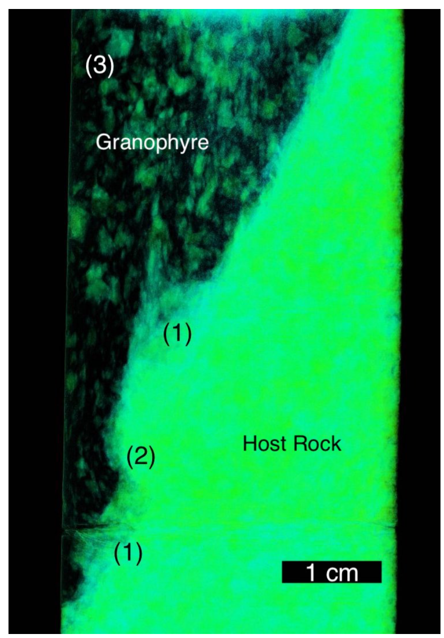

Fig. 3: Interpreted virtual section from the 16-bits CT data. Low density materials (e.g., granitoid) in green, high density materials (e.g., granophyre) transparent in this image. 1) Plumes of melt rise from melting host rocks. 2) Plumes flow around blocks of unmelted host rocks. 3) Elongate enclaves of immiscible silica melt within the granophyre.