Pseudotachylitic Breccia and Microfracture Networks in Archean Gneiss of the Central Uplift of the Vredefort Dome, South Africa.

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Pseudotachylitic breccias are the most prominent impact-induced deformation structures in the central uplift of the Vredefort Impact Structure (Dressler & Reimold, 2004; Reimold & Gibson, 2006). These breccias can be investigated in detail in a range of host lithologies. The exact mechanisms by which such melt breccias in impact structures form, by either impact melting, friction melting, decompression melting, or a combination of these processes, remains to be elucidated (Reimold and Gibson, 2005). Regarding the formation of friction melt, the Vredefort Dome does not evidence the large fault/ shear zones required to produce such huge volumes of melt.

Previous work has focused on orientation and geometry of pseudotachylitic breccia veins. Moreover, detailed geometric analysis of breccia bodies, including veins and dikes, was hampered by limited outcrop and has not been adequately related to microdeformation studies of pseudotachylitic breccia. This study uses a different approach by analysis of a polished 3 x 1.5 m granite slab from a dimension stone quarry in the western core of the dome. This provides an ideal opportunity to investigate the relationship between generation of fractures with and without melt, fracture and breccia intensity, and other geological characteristics such as lithology, grain size and mineral fabrics, by field work.

Optical microscopy shows that the Archean gneiss of the Vredefort Dome was affected by 2 microfracture-forming deformation events, one preceding melt emplacement and one following the emplacement of pseudotachylitic melts into dilation zones. The older microfracture generation also occurs in cross-cutting relationships with pseudotachylitic breccia veins. We suggest that these relationships depend on different cooling rates of melt veins of different thickness, while microfracturing continued. Fracture opening and melt intrusion were quasi contemporaneous.

Optical and scanning electron microscopy point to melt flow into dilation sites, i.e., from larger to smaller dilational sites. This has also been observed at the meso-scale (dm to mm). Fillings of the older microfracture system contain chlorite, which is likely a secondary phase. Filling of secondary carbonate in the younger fracture system indicates that this fracture system was filled in a much colder environment, likely after the impact event. Unravelling the development of individual structural components resulted in a sequence of 4 processes involving both deformation of the target rock and melt emplacement into the deformed host rock. What remains is to unravel the stated problem of how this melt originated in the first place. To this effect detailed microchemical studies are currently underway and results will be presented at the conference.

References

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