Geophysical Research Abstracts
Vol. 19, EGU2017-3769, 2017
EGU General Assembly 2017
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Pseudotachylitic breccia in mafic and felsic rocks

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Impact-produced pseudotachylitic breccia (PTB) is abundant in the core of the Vredefort impact structure and was found in many pre-impact lithologies (e.g., Reimold and Colliston, 1994; Gibson et al., 1997). The mechanisms involved in the process of forming this rock remain highly debated, and various authors have discussed many possible models. We investigate PTB from two different rock types: meta-granite and meta-gabbro and test how lithology controls the development of PTB. We also report on clast transport between different lithologies.

In the core of the Vredefort impact structure, meta-granite and meta-gabbro are observed in contact with each other, with an extensive set of PTB veins cutting through both lithologies. Microstructural analyses of the PTB veins in thin sections reveals differences between PTBs in meta-granite and meta-gabbro. In granitic samples, PTB often develops along contacts of material with different physical properties, such as a contact with a migmatite or pegmatite vein. Nucleation sites of PTB have features consistent with ductile deformation and shearing, such as sigmoudal-shaped clasts and dragged edges of the veins. Preferential melting of mafic and hydrous minerals takes place (e.g., Reimold and Colliston, 1994; Gibson et al., 2002). Refractory phases remain in the melt as clasts and form reaction rims.

In contrast, PTB in meta-gabbro develop in zones with brittle deformation, and do not exploit existing physical contacts. Cataclastic zones develop along the faults and progressively produce ultracataclasites and melt. Thus, PTB veins in meta-gabbro contain fewer clasts. Clasts usually represent multi-phase fragments of host rock and not specific phases. Such fragments often originate from the material trapped between two parallel or horse-tail faults.

The lithological control on the development of PTB does not imply that PTB develops independently in different lithologies. We have observed granitic clasts within PTB veins in meta-gabbro, demonstrating clast transport between lithologies. PT melt in meta-gabbro has a two-phase structure: a phase free of granitic clasts, and a phase that contains granitic clasts. This also indicates that melt in both rock types was mobile during the same period of time, and that physical mixing and chemical exchange occurred between the two melts. Thus, PTB cuts across the contact between granite and gabbro, and is not restricted by the contact (e.g., Reimold and Colliston, 1994).

These differences in nucleation and propagation of PTB based on rock type must be considered when discussing the formation mechanisms of impact-generated PTB.

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