IMPACT BRECCIAS IN THE CENTRAL VREDEFORT DOME – REVISITED

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Breccias in the central Vredeford Dome are pseudotachylite (pt) (or pseudotachylitic breccia **[1]**), impact melt breccia (i.e., Granophyre dikes) and, at as ingle place in the center of the Dome, a breccia that is similar to the Footwall Breccia of the Sudbury Structure. We recently carried out further detailed field investigations ay numerous exposures of the Archean basement complex in the core of the Dome. These field investigations allow us to refine earlier observations and interpretations **[2, 3]** of the origin and emplacement mechanisms of these breccias.

Pts are the most common type of breccia in the Vredefort Dome. In 2001, we speculated **[3]** that the long, linear pt zones could have a zigzag configuration radiating from the center of the structure. However, we could not substantiate this interpretation in our recent field investigations. Veins, dikes, and large zones of these breccias apparently do not have a preferred orientation with respect to the geometry of the Vredefort Dome and our present data strongly suggest that their orientation is also independent from the orientation of pre-impact structures of the host rocks, such as gneissosity or lithological banding. Large dimension stone quarries and several large hills with excellent outcrops provide superb three-dimensional views of many breccia bodies; these bodies dip mainly steeply or vertically (Fig.1). Smaller exposures commonly also exhibit breccia dikes and veins with no apparent preferred orientation with respect to the geometry of the Dome (Fig.2).

Large pt breccia zones commonly have "mother lode" central dike-like bodies. In the central Vredefort Dome, these massive dikes are up to 18 m wide and are accompanied by randomly branching veins and dikes, which have commonly been interpreted as apophyses of the mother lode. However, we have chemical evidence that at least some of the very thin (<1 cm) branches are not apophyses but were formed by strictly *in-situ* melting and not by injection from a large central pt body. While frictional heating may have played a role in the formation of pts, it is unlikely that - in central parts of impact structure floors - friction is the sole or major contributing process responsible for the generation of the massive and wide pt mother lodes and the branching veins and dikes associated with them. Localized melting and the randomness of breccia orientation are mainly the result of chaotic, explosive transfer of thermal (shock) energy away from ground zero. While pts in central parts of impact structures may also be initiated through friction at local heterogeneities in target rocks, – such as lithological contacts and faults – melting spreads from there in a random, explosive fashion.

The random distribution of pt bodies in central parts of large impact structures is different from that of pt bodies in the country rocks around the excavation cavity of large impact structures, such as around the Sudbury Basin. At this Canadian impact structure, pt bodies have been interpreted as having been generated as a result of terrace collapse and multi-ring basin formation **[4,5]**. It may very well be that the large breccia bodies around the Sudbury Basin are mainly the result of cataclasis and frictional heating, similar to the formation of pseudotachylites along fault and shear zones in tectonic regimes.

Vredefort Granophyre has been interpreted as impact melt breccia. Dikes of this second, major type of impact breccia straddle the arcuate boundary of the central granitoid core with the supracrustal rocks of the collar and occur also within the Archean gneisses of the central core. In the latter setting, they are oriented radially with respect to the geometry of the structure. They are very homogeneous in chemical composition and have recently been shown **[6]** to contain shocked clasts representing a wide range of shock deformation (~5 to >45 GPa). For these reasons, the Granophyre is interpreted to represent an initial impact melt formed through melting of various target rocks **[7]**.

No exposures of "*Footwall Breccia*" as it is known from the Sudbury Impact Structure are known in the Vredefort Dome. In the Sudbury Structure, this enigmatic breccia forms discontinuous, kilometer-long bodies beneath the Sudbury Igneous Complex (SIC), grades into the underlying footwall rocks, and consists of footwall rock fragments in a contact metamorphic, strongly recrystallized matrix **[8]**. The origin of the breccia is enigmatic but it was obviously formed by crushing and minor displacement of rocks of the transient crater floor prior to the emplacement of the SIC. At Vredefort, we observed several large boulders of breccia in the central Dome area, about 4 km south of the geometric center of the impact structure on Farm Windham that appears similar to the Sudbury Footwall Breccia. These breccia blocks are characterized by basement rock clasts up to ~10 cm in size embedded in a leucocratic, fine- to medium-grained matrix. No outcrop of this breccia has been found. Ongoing research will show whether this Vredefort breccia is an equivalent to the Sudbury Footwall Breccias or not. If it is, we would have to conclude that the present erosional surface of the central Dome area is more or less the original floor of the excavation cavity, just beneath the eroded impact melt sheet, believed to have occupied the lower excavation cavity of the Vredefort Structure.

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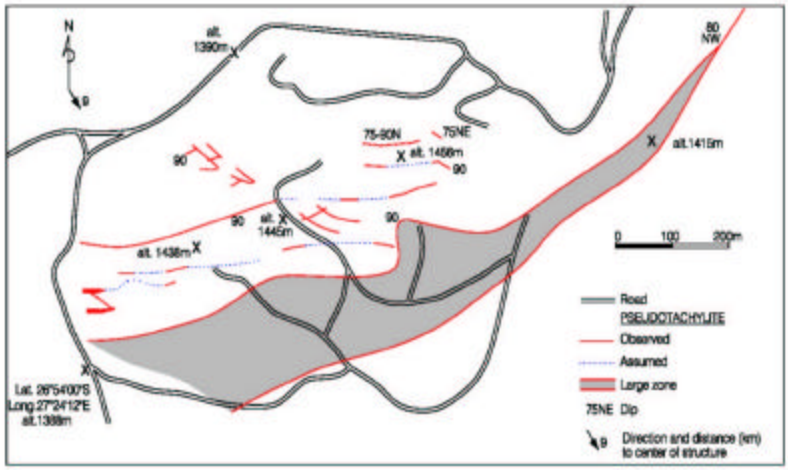

Figure 1: Pt occurrence of 65-m high Leeukop Hill, north-central Vredefort Dome. Most pts dikes dips are steep to vertical. The mapping of the large northeast-trending pt zone is based on a number of exposures and the tracing of large pt boulders.

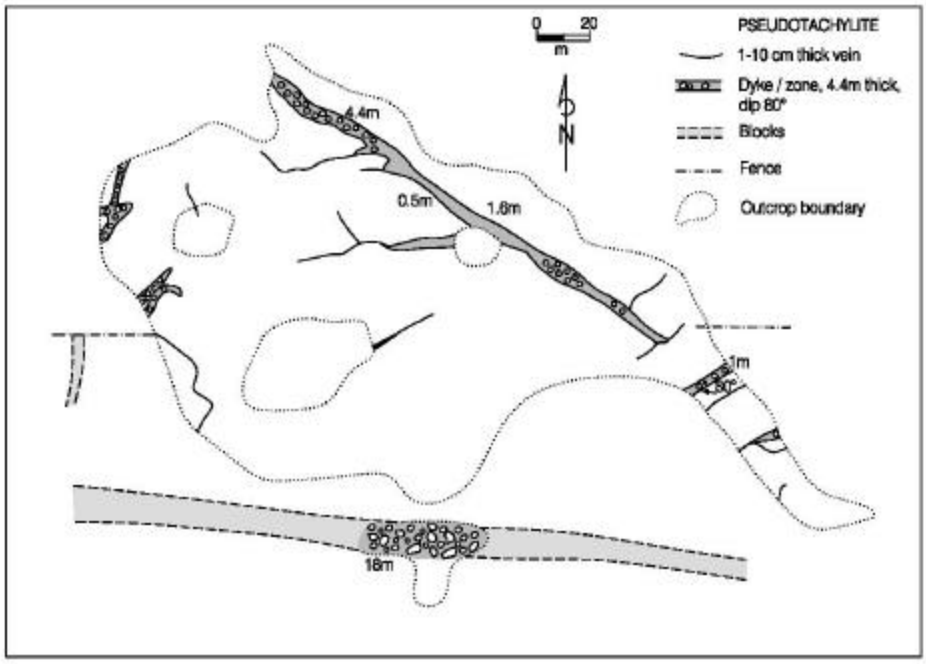

Figure 2: Pt dikes on Rooipoort Farm in the northwestern Vredefort Dome. Note the various trends of the pt dikes and zones.