ELEMENTAL ANALYSIS OF MUSGRAVE PROVINCE PSEUDOTACHYLITE.

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Introduction: The pseudotachylite breccia deposits of Musgrave Province of Australia, are up to about 5 km wide and run intermittently for 300 km with approximately 10% pseudotachylite veining. The veins are range in width from a few centimeters up to 4 m and can be traced for up to 10 m. The orientation of the veins appears to be random. Pseudotachylites occur only in the granulite facies rocks. Rotated blocks of ultramylonite are present in some of the Pseudotachylites, and some pseudotachylyte veins have been plastically deformed, suggesting nearly contemporaneous semiductile and brittle behavior. [1][2][3][4][5]

The early researchers interpreted the pseudotachylite breccia from the Musgrave Province as generated by normal seismic processes despite the enormous volume of the melt.[1][2][3][4] This seismic interpretation continues even though some pseudotachylite deposits are radial to a suggested impact center (MAPCIS) and occur 40km away from the Woodroofe Thrust Fault. [6]

Goal: Present study endeavored to differentiate the Musgrave pseudotachylite, terms of impact vs. seismic through elemental analysis within the melt and the wall rock, as well as comparing it to known impact Pseudotachylites. Musgrave pseudotachylite breccia samples from proximal (40km) and distal (100km) from the proposed impact center were analyzed and compared to samples from Sudbury of Canada and Vredefort of South Africa.

Methodology: Pseudotachylites samples were very carefully separated from the host with a slow cutter for elemental analysis. Elemental mapping by µ-XRF (Broker Tornado M4) was used to comprehend the connection of the elemental composition of the pseudotachylite melts as well as wall rocks. X-ray Diffraction (XRD) analysis of the separated pseudotachylite melts were also conducted by using both Cu and Co source, for further validation of the results. The concentration of the Platinum group elements (PGE) were determined using a nickel sulphide (NiS) fire assay procedure and ICP-MS.

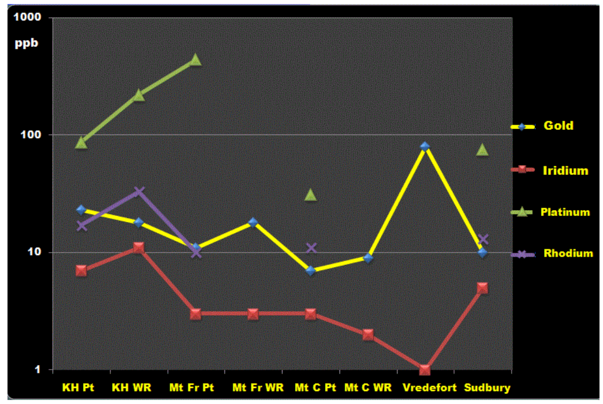

Fig. 1. Kelly Hills (KH) of eastern Musgrave range is the closest outcrop to the center of MAPCIS.

Results: The PGE assay revealed concentrations of iridium orders of magnitude higher than what would be expected in continental crust in all the Musgrave samples. Both melt and wall rock Ir concentrations were higher, closer to the impact center. The Musgrave Ir concentrations were equal to or higher than found in either the Sudbury or the Vredefort samples. The µXRF spectrometry revealed concentrations of iron and cobalt to be significantly higher in the Musgrave pseudotachylite melt as compared to the wall rock.

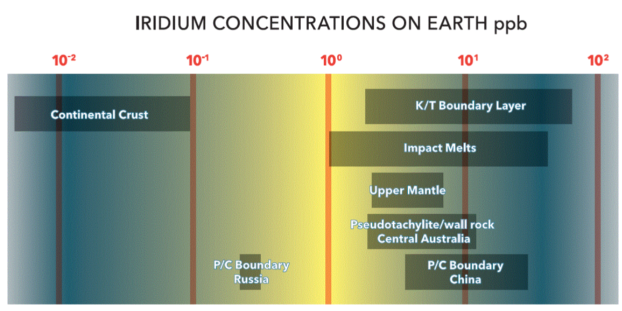

Fig. 2. Central Australia iridium concentrations are consistent with impact origin although mantle contamination must be ruled out.

The matrix of the pseudotachylyte veins is less siliceous than the host rocks, owing to non-equilibrium melting of pyroxene, garnet and plagioclase. The igneous assemblages of the melt, notably the crystallization of pigeonite, are consistent with rapid cooling from very high-temperature (>1000°C). Melting and quenching is probably due to very local, short-lived rises in temperature accompanied by dilation.

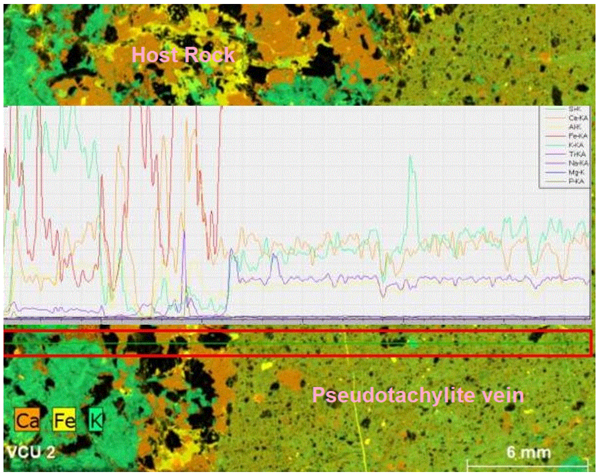

Fig. 3. Pseudotachylite composition is characteristically relatively depleted in Ca, Mg, Mn and H2O than the host rock, but the Musgrave pseudotachylite veins are relatively enriched in Ca, Mg and Na along with Fe and Ti, perhaps due to instantaneous non-equilibrium melting and very high oxygen fugacity.

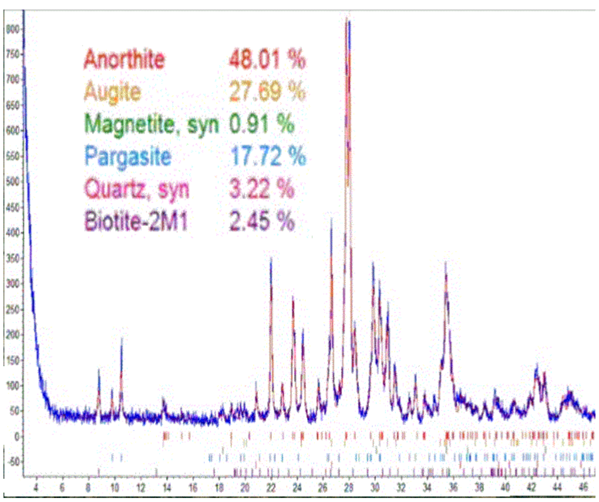

Fig. 4. XRD profile of separated pseudotachylite vein. Energy discrimination settings were used to reduce fluorescence due high concentration Fe and the phases were identified by using DIFFRAC.EVA. The presence of pargasite [NaCa2(Mg4Al)(Si6Al2)O22(OH)2] in the vein ruled out the anhydrous origin of the Musgrave pseudotachylites. [5] [7]

Conclusion: The results suggest that the Musgrave pseudotachylite is impact generated and that a portion of the melt is from the bolide. This is a significant discovery that should lead to a reexamination of the origins of Musgrave pseudotachylite breccia. The seismic origin was probably a misinterpretation owing to the proximity of pseudotachylite veins to the Woodroffe Thrust Fault, though the occurrences of pseudotachylites are restricted in the footwall and tens of km apart from the mapped thrust zone.

References: [1] Camacho A., et al. (1995) *Journal of Structural Geo.*(17)#3371-383 [2] Glikson A.Y. & Mernaugh T.P. (1990) *Journal of Australian Geology & Geophysics* 11, 509-519 [3] Wenk H.R. &Weiss L.E. (1982) *Tectonophysics, 84, 329-341* [4] Wex et al. 2017 *Tectonics*, 36, 2447–2476, [5] Wex S, et. al. (2018) *Solid Earth*, 9, 859–878, 2018 [6] D. Connelly (2012) GSA Charlotte Abstract 104-3 [7] Green, D H, et. al. (2010) *Nature*. 467 (7314): 448–451.