PSEUDOTACHYLITE BRECCIA OF THE MUSGRAVE PROVINCE, AUSTRALIA

Daniel Connelly

MAPCIS Research Project,
Email: danielconnelly@comcast.net

Primary Researcher
Amateur with a passion
World Traveler
University of the Sciences
Pharmacist

Abstract

Pseudotachylite breccia from disparate locations in the Musgrave Province were collected for study. The expedition team hiked to locations 40km, 60km and 100km from a proposed impact site, known as MAPCIS, and collected 2kg to 5kg samples that contain pseudotachylite breccia. The samples were initially sliced in Coober Pedy and Adelaide and were later verified as pseudotachylite breccia, by both Actlabs Ltd. and Applied Petrographic Services Inc. We attempt to put these pseudotachylite breccia into context of a possible impact and compare the geomorphology to pseudotachylite breccia of the Vredefort structure, South Africa. Although pseudotachylite breccia in central Australia are not rare and are contained within the largest known deposits on Earth, they are relatively unknown and unstudied. Portions of these samples were donated to the Australian Museum, Sydney, the South Australian Museum, Adelaide and the Queensland Museum, Brisbane. These samples were the first of their kind in each museum collection. We hope to stimulate further research in this area and work to towards more precise dating of the pseudotachylite breccia.

Introduction

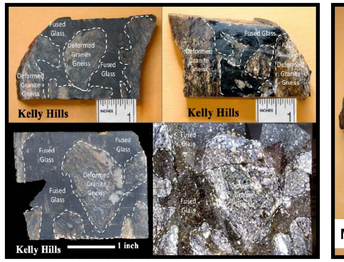
This is the fifth year since the rediscovery of the ring structure initially known as CAR, Central Australian Ring and is now associated with MAPCIS, Massive Australian Precambrian/Cambrian Impact Structure. Seven oral or poster presentations on diverse aspects of MAPCIS were given, culminating with the most recent at the **34th IGC** in Brisbane. There are also three associated published papers with Chinese astrophysicists. Although MAPCIS is well on its way, the journey from discovery of initial evidence to confirmation of a structure as an impact usually takes 10 to 30 years. Besides collecting evidence and presenting it, the most important thing I can do is to raise awareness of MAPCIS so that others may add their expertise.

To learn about the earlier work, go to the Geological Society of America website and search past meeting abstracts for MAPCIS to get downloadable presentations.

Objectives

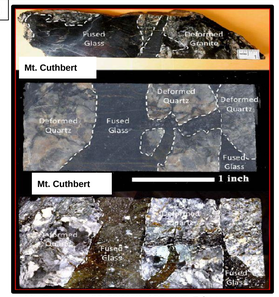
1. To collect samples of pseudotachylite from representative formations in the Musgraves with the highest possible distance between samples.
2. To collect sufficient quantities for future research and dissemination of samples to other researchers.
3. To positively identify the samples.
4. To get these samples dated. (40Ar/39Ar pending)
5. To show by comparison with maps based on Vredefort SA that the amount and location of pseudotachylite breccia near MAPCIS is not unusual for an impact.

"These three rocks (sites) indeed appear very similar - both macroscopically and microscopically." Dipayan Jana, PhD, PG (APS)

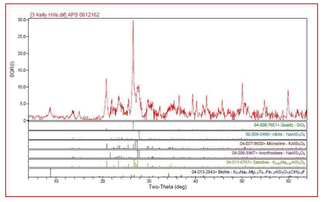


Kelly Hills - 25 49'35"S 131 29'41"E a low mound outcrop with surrounding plain ~300m by 300m. Pt breccia throughout. Possibly part of 12km long radial deposits

Mt. Fraser - 25 57'34"S 131 38'39"E from outcrop near mountain top and part of a 13km long radial deposit

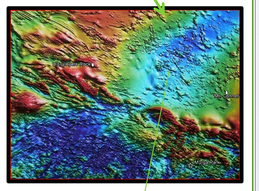


Mt. Cuthbert - 25 59'11"S 132 11'5"E from large deposit of Pt Breccia zone that is ~5km wide and the eastern end of 300km long zone of deposits.



X-ray diffraction of the Kelly Hills sample showing the presence of Quartz, feldspar (albite, microcline, anorthoclase, sanidine), and mica (biotite) in the pre-existing granitic rocks. D. Jana

Ayers Rock Map 2002 Magnetic Intensity Anomaly
Suggests a deep trench under the plain between Uluru/Ayers Rock and Mt. Conner.

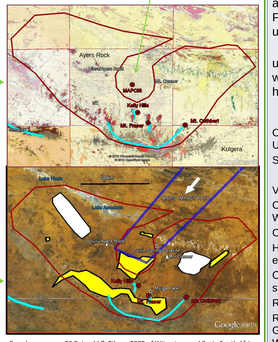


Age resets of protolith ~1.2Ba during the Petermann Orogeny 550-535Ma to:

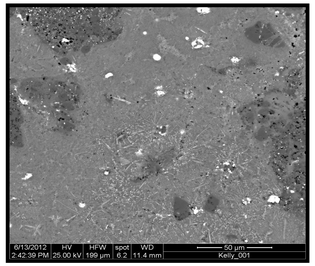
1. Mylonitised pegmatite 547Ma 9
2. Mylonitised granite 540Ma 6
3. Mylonite 546Ma 6 (marker partially covered by 2)
4. Mylonitised granite 558Ma 2
5. Mylonitised granite 539Ma 6

From Northern Territory Geological Survey, Report 15

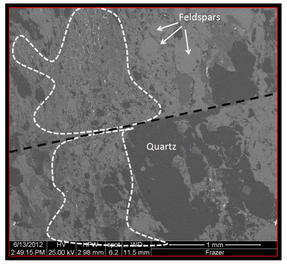
2011 expedition sample sites are noted by red circles at Kelly Hills, Mt. Fraser and Mt. Cuthbert. It is expected that the dating of the Pseudotachylite will concur with NTGS Report 15 and more tightly constrain the event.



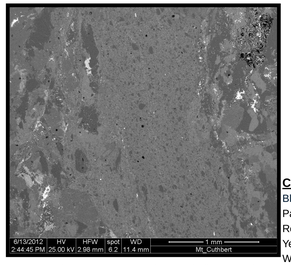
Based on map pg. 23 Reimold & Gibson 2005 of Witwatersrand Basin South Africa.



Kelly – Microstructure of pseudotachylite matrix with skeletal Fe-oxides indicating quench-cooling . Larger darker bodies are quartz and quartz-feldspar breccia fragments. CH



Fraser - Microstructure (Pseudotachylite schlieren in stippled lines) CH



Mt. Cuthbert - Pseudotachylite as vein-like central material within coarser grained, granitic material. The 'frothy', fine-grained and micro-brecciated appearance is typical of common pseudotachylite. CH

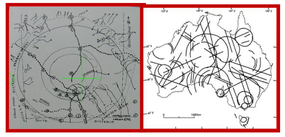
Comparison Vredefort Impact South Africa with MAPCIS Australia

Blue- Proposed path of MAPCIS
Pale Blue- Locations of massive pseudotachylite breccia in Musgraves
Red- Outline of Witwatersrand Basin & Vredefort Impact over Amadeus Basin
Yellow- Areas with pseudotachylite breccia at Vredefort Impact
White- Areas with no pseudotachylite breccia at Vredefort Impact. Bilateral white areas of Vredefort are of interest since they match places where the target rock survived at MAPCIS.

Drainage Map Outlines Ring

1969 Div. Nat. Map noted by O'Driscoll & Campbell 1997

CAR Central Australian Ring



1993 B. Cramer considers impact origin of CAR

1997 E.S.T. O'Driscoll & I. B. Campbell consider origin of CAR. Meets "square root of 2 rule" for impact rings.

Far-field ring from satellite images

2006 G. Harvey & 2007 D. Connelly independently discover the outer ring and consider an impact origin.

Kalkarindji igneous event surrounds higher ground

2010 Based on Jon Claoué-Long & Dean Hoatson Kalkarindji LIP ~540Ma – 500Ma
Red dot is the impact center

Inner ring which fits inside the donut to the left

2011 D. Connelly mosaic map based on 1:250,000 GA Geology Maps shows inner ring

1983 first intraplate model for Petermann Orogeny — **Conflicting models created for the short duration, violent, intraplate Petermann Orogeny ~550Ma- 535Ma without ruling out an impact.**

Anangu Pitjanjatjara Yankkunyjatjara Land Rights Act 1981 severely limits access to the Musgrave Province.

Connection between impact craters and pseudotachylite develops. — **Large volume pseudotachylite breccia become associated with impact origin, not yet for Musgraves.** ?

H.R. Wenk & L.E. Weiss study origin of Musgrave pseudotachylite 1982

Glikson, A. Y., Mernagh, T. P., study Pseudotachylite in western Musgraves 1990

Camacho A., Vernon R.H., Fiztgerald J.D. contemplate impact origin of Musgrave pseudotachylite 1995

2008 D. Connelly goes to Australia & discovers that the pseudotachylite is near the proposed impact center

2011 D. Connelly collects Musgrave pseudotachylite breccia for research and dating. Searches for PDFs as well, in nearby SS outcrops.

Discussion

Musgrave Pt. breccia deposits have been described as massive, voluminous, kilometers wide zones that contain anywhere from 4 % to 10% pseudotachylite. The finding of pseudotachylite breccia at these sites was not in question. Pt. breccia was found in all the marked or suggested locations from the GA 1:250,000 Ayers Rock & Kulgera Geology Maps. When compared, the center of impacts of MAPCIS with Vredefort allow us to visualize that size difference is minimal and the location and volume of Pt breccia in relation to the centers is comparable. If the Witwatersrand basin were not labeled, it could be mistaken for MAPCIS in the Amadeus Basin.

Early research always suggested a normal seismic origin and rightly so, as pseudotachylite had not yet been associated with an impact origin. Individual sites of studied Pt. breccia, being so widely dispersed in the Musgraves gave no clue to the location or direction of a possible impact center. The repeated discovery of CAR and concentric rings were never connected with the Pt. Breccia until the center was found using the outer Far-field ring. In the intervening decades, several models were developed in an attempt to explain events surrounding the enigmatic Petermann Orogeny ~550-535Ma. While these models continue to be modified, research into the Pt. Breccia has stalled.

The future of this research is vibrant and exciting with each discovery often leading to a new branch of science to which it is connected: Geology, Cosmecology, Biology, Physics and Chemistry. The many branches of Geology will be needed to fully understand this impact.

The 34th IGC in Brisbane gave my next area of research. A lot was developed in the understanding of tsunami deposits from marine impacts. The target of the MAPCIS bolide was the Centralian Superbasin making this a marine impact. These deposits appear to have a worldwide distribution and that is the next expedition.

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