VAALBARA AND TECTONIC EFFECTS OF A MEGA IMPACT IN THE EARLY ARCHEAN 3470 Ma

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Abstract
The oldest impact related layer recognized on Earth occur in greenstone sequences of the Kaapvaal (South Africa) and Pilbara (Australia) Craton, and have been dated at ca. 3470 Ma (Byerly et al., 2002). The simultaneous occurrence of impact layers now geographically widely separated have been taken to indicate that this was a worldwide phenomena, suggesting a very large impact: 10 to 100 times more massive than the Cretaceous-Tertiary event.
However, the remarkable lithostratigraphic and chronostratigraphic similarities between the Pilbara and Kaapvaal Craton have been noted previously for the period between 3.5 and 2.7 Ga (Cheney et al., 1988). Paleomagnetic data from two ultramafic complexes in the Pilbara and Kaapvaal Craton showed that at 2.87 Ga the two cratons could have been part of one larger supercontinent called **Vaalbara**.

New Paleomagnetic results from the older greenstone sequences (3.5 to 3.2 Ga) in the Pilbara and Kaapvaal Craton will be presented. The constructed apparent polar wander path for the two cratons shows remarkable similarities and overlap to a large extent. This suggests that the two cratons were joined for a considerable time during the Archean. Therefore, the coeval impact layers in the two cratons at 3.47 Ga do not necessarily suggest a worldwide phenomena on the present scale of separation of the two cratons.

Although the impact 3470 Ma impact may have been more limited in size than previously thought, it is interesting to test if geological events described for the Pilbara and Kaapvaal Craton may represent the structural and magmatic results of an impact. The time series correlation between Lunar and Earth impact history and periods of high volcanic activity (Abbott and Isley, 2002) suggest that there is a causal relationship between crustal growth and meteorite impacts. The era between 3490 and 3400 Ma represents one of the best documented periods in which felsic continental crust was formed by intrusion and extrusion of TTG (tonalite, trondhjemite, granodiorite) melt. The stratigraphy consists almost entirely of mafic to ultramafic volcanic rocks and minor felsic (TTG) volcanic rocks. In this stratigraphy it may not be possible to distinguish impact melts from normal volcanic rocks. In both the Pilbara and Kaapvaal Craton extensional faults have been described, which were active at ca. 3470 Ma, during felsic volcanism and broadly coeval with the impact layers (Zegers et al., 1996, Nijman et al., 1998). These extensional structures have been interpreted as the result of caldera collapse (Nijman et al., 1998, Van Kranendonk et al, 2002) or as the result of delamination of lower crustal eclogite (Zegers and Van Keken, 2001). The question remains if there is any evidence in the geological record that this magmatic event could have been triggered

by meteorite impacts. We will examine the possibility that these extensional fault patterns represent multi ring faults associated with a large impact.

The early Archean greenstone terrains can be regarded as the closest analogue to Martian geology. Therefore the study of impact features in the Pilbara Craton may have implications for understanding impact features on Mars.

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