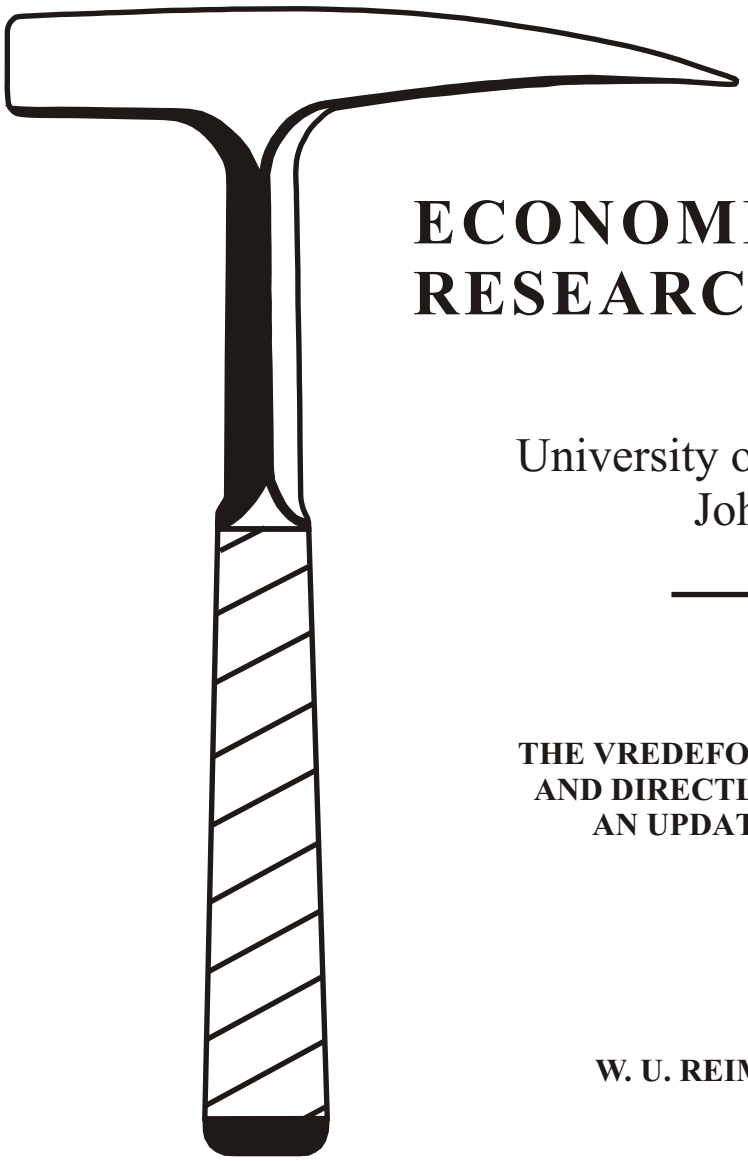

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THE VREDEFORT IMPACT STRUCTURE AND DIRECTLY RELATED SUBJECTS: AN UPDATED BIBLIOGRAPHY

W. U. REIMOLD and L. CONEY

• **INFORMATION CIRCULAR No. 353**

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July, 2001

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INTRODUCTION

The Vredefort Dome, in the centre of the Witwatersrand Basin, represents the central uplift of the world's largest and oldest preseved impact structure. Impact cratering and Witwatersrand and regional geological considerations continue to stimulate research on this structure. As a consequence the Vredefort literature has grown extensively since an earlier bibliography on this subject was compiled by W.U. Reimold and G. Levin in 1991. This bibliography appeared as EGRU Information Circular No. 242 (November, 1991). The present compilation provides an update on the literature pertaining to the Vredefort Structure and closely related topics.

The Vredefort Dome, located some 120km southwest of Johannesburg in the approximate centre of the Witwatersrand Basin, represents a near-circular structure of uplifted supracrustals and crystalline basement. The origin of this Structure has been debated since the beginning of the 20th century (e.g., Hall and Molengraff, 1925; du Toit, 1954; Nicolaysen and Reimold, 1990; Reimold and Gibson, 1996). Mainly on the basis of a somewhat circular geometry, the presence of shatter cones, massive pseudotachylitic breccias and the discovery of the high-pressure polymorphs coesite and stishovite, an origin by impact of a large extraterrestrial projectile has been invoked, first by Daly (1947) and then by others during the late 1950s. Reviews by Reimold and Gibson (1996) and Gibson and Reimold (2000) showed that this hypothesis initially proved to be highly controversial. However, new evidence, obtained since 1994, provided compelling support for the Vredefort Dome having originated following a large meteorite impact event. This evidence includes confirmation that the planar deformation features found in quartz represent *bona fide*, impact-diagnostic shock deformation features (Leroux et al., 1994). Planar features of shock origin and the so-called “strawberry texture” of high-temperature origin were described from zircons in Vredefort rocks (Kamo et al., 1996; Gibson et al., 1997a). In addition, and using the sensitive Re-Os isotope method, a very small meteoritic component was detected in the Vredefort granophyre (Koeberl et al., 1996). This rock type, because of its regional homogeneity, had long been suspected of representing impact melt rock. Recently, Buchanan and Reimold (2001) observed quartz-bearing clasts in granophyre samples that also display planar deformation features. The impact origin of the Vredefort Dome is no longer controversial.

U-Pb dating by SHRIMP or conventional TIMS analyses of single, unshocked zircon crystals from a number of Vredefort rocks, including granophyre and pseudotachylitic breccia, both of which have been accepted as having formed at the time of the impact event, resulted in ages scattering around 2020 million years, with an error of approximately 5 million years (Spray et al., 1995; Kamo et al., 1996; Gibson et al., 1997a; Moser, 1997). This age is taken as the best estimate for the timing of this impact event.

The Vredefort literature contains a wide range of size estimates for the Vredefort Structure: values between 70-80 km (the diameter of the Vredefort Dome) and 140 km (the distance from the centre of the dome to the northern margin of the Witwatersrand Basin) have been reported. Recently, however, estimates of the original size of the Vredefort impact structure have resulted in much larger values being proposed: hydrocode modelling of a large-scale impact event recommends an original diameter of *c*. 160 km (Turtle and Pierazzo, 1998). Integrated geophysical modelling prefers much larger values of 250-300 km (Henkel and Reimold, 1998). This result is also supported by scaling studies of the spatial distribution of shock and other deformation features around the Vredefort Dome (Therriault et al., 1997). Consequently, it is now widely accepted that the Vredefort impact structure represents the world's largest, and oldest, known impact structure.

Whereas the controversy surrounding the origin of the Vredefort Structure has been resolved, a number of other aspects of this geological feature remain controversial. Some workers have proposed that a complete cross-section through the crust, and even extending into the upper mantle, is exposed along a radial traverse towards the centre of the Vredefort Dome. It is suggested that upper and middle crustal strata were juxtaposed along a major discontinuity between the Outer Granite Gneiss and the Inlandsee Leucogranofels terranes in the the core region of the Vredefort Dome. Other workers, based on structural geological findings, do not support this hypothesis.

Impact workers recognize the importance of the Vredefort Dome for understanding the processes involved in the formation of the central uplift of large impact structures. Nowhere in the world is such a gigantic impact structure so well exposed, and at such a deep erosion level. This affords a unique cross-section through the deep floor of the Structure. Neither Chicxulub in Mexico (which is completely covered), nor Sudbury in Canada (which is much less deeply eroded than Vredefort and is mostly covered by the impact breccias of the Sudbury Igneous Complex), allow such studies.

The central position of the Vredefort Dome in relation to the economically important Witwatersrand Basin has been known for a long time; however, few workers have, in the past, considered the effects of the Vredefort impact on the basin and its associated gold resources. To address this issue geological, geophysical, and mineralogical studies are currently being undertaken. Furthermore, the geological community is in general agreement that the Vredefort Dome represents a unique window into the crust of the Kaapvaal Craton. For all these reasons, major research efforts continue. Since the first bibliography compiled by Reimold and Levin (1991), a massive body of published materials has been produced by South African and overseas researchers. It was thus deemed important to provide an updated bibliography of the Vredefort literature in order to keep researchers informed of recent developments concerning this exceptional geological structure.

The references listed in the bibliography are of two types. Most of the literature pertains directly to the Vredefort Structure itself, but also listed are works that discuss geological or physical aspects with reference to Vredefort, or that have significant importance to Vredefort, the surrounding Witwatersrand Basin and to impact researchers.

A number of colleagues in South Africa and overseas have supported this effort by providing current lists of relevant publications and we would like to thank them for their support. The cut-off date for references included in the bibliography was May, 2001. Should, however, some published information have escaped our attention we would like to extend our apologies and would appreciate being notified of these works for inclusion in a future update.

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Published by the Economic Geology Research Institute
(incorporating the Hugh Allsopp Laboratory)
School of Geosciences
University of the Witwatersrand
1 Jan Smuts Avenue
Johannesburg 2001
South Africa

http://www.wits.ac.za/egru/research.htm

ISBN 1-86838-288-5

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