

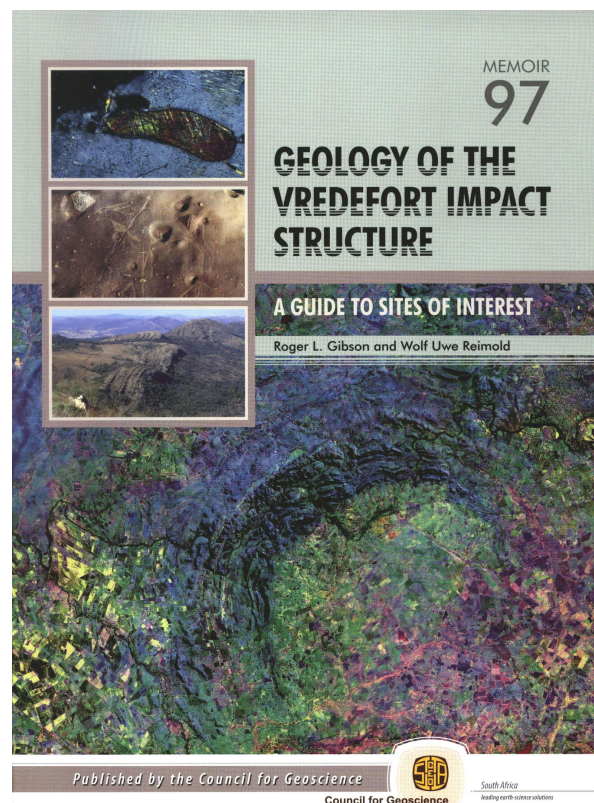
## Book Review

*Geology of the Vredefort impact structure: A guide to sites of interest*, by Roger L. Gibson and Wolf Uwe Reimold. Pretoria, South Africa: South African Council for Geoscience Memoir 97, 2008, 181 p., R250 (\$58.00), paperback (ISBN 978-1-920226-10-7)

The Vredefort impact structure, centered about 120 km southwest of Johannesburg, encompasses a region with exceptionally rich cultural, historical, and geoscience heritages. To mining geologists, Johannesburg—or “Egoli,” meaning the “City of Gold”—is well known as a world’s leading producer of gold and other valuable minerals, including recovery from the deepest gold mines on Earth. To impact and planetary geologists, however, the real gem of the region is the 90-kilometer-wide central core of the Vredefort impact structure—the Vredefort Dome. The dome presents not only a unique and superbly exposed cross section through deep levels of the impact structure, but also provides a deep window into the world-class Archean and Paleoproterozoic rocks of the Kaapvaal craton. In July 2005, the northwestern part of the dome was declared a World Heritage Site. Work is currently underway to strengthen the geotourism infrastructure in the site, including finishing construction of a natural heritage visitor center.

The Dome is the home to many “firsts” within impact geoscience: it is the exhumed, uplifted central collar and core of the world’s oldest (2.023 Ga), largest (180–300 km in diameter), and most deeply eroded, preserved impact structure; it is the type region of the enigmatic pseudotachylite (or pseudotachylitic breccia of current usage), a voluminous, impact-related, sub-crater melt-rich breccia, the origin(s) of which is still being debated; and, of vital importance to many geoscientists studying potential impact structures elsewhere, it has become a proving ground for identifying and understanding such diagnostic impact indicators as shatter cones, high-temperature and -pressure mineral polymorphs, shock-metamorphic mineral microstructures, and impact-derived geochemical anomalies. Ongoing debate regarding the endogenic versus exogenic origin of many circular structures on Earth hinges on observations, data, methodologies, and modeling that have their roots in classic studies from Vredefort Dome.

Building on the popular field guide prepared for the 62nd Annual Meeting of the Meteoritical Society in 1999, as well as helping to fulfill a need for an updated visitors guide to accompany opening of the World Heritage Site, this book gives an accessible yet rigorous compilation of the geologic



history of the Vredefort impact structure, together with a field guide for accessing key localities to understand the pre-, syn- and post-impact geologies of the region. The guide, divided into three parts, is richly illustrated with color figures and photographs that highlight many current studies and hypotheses on the origin of specific impact-related features of the dome.

Part one gives a well-balanced introduction into the regional geology and history of study of the Vredefort impact structure. Included in this section are discussions of its geological setting, previous endogenic models for its origin, shock-metamorphic and other impact evidence for its origin, mechanics of large impact structures, age and size of the Vredefort impact structure, geophysics and numerical modeling of the structure, and possible preserved evidence of the impact event beyond the structure. Part two of the guide provides a detailed summary of the geological development of the pre-impact, Archean crystalline basement complex exposed in the core of the dome. Including discussions of metamorphic petrology and petrography, structure,

geochronology, geochemistry, and geodynamic modeling, this chapter builds an important geological framework that is necessary not only for recognizing the anomalous changes resulting from the impact event but also for understanding the larger scale, inter-regional geologic context of the event.

Finally, in part three, which encompasses nearly half of the guide, a total of 26 field trip stops are described, with selected localities in both the collar and core of the dome. Detailed stop descriptions include driving directions and maps, instructions for obtaining appropriate permission to access outcrops, and pertinent geologic background information to fully appreciate the significance of each stop. Stops #1–12 in the ring-shaped collar highlight the regional and impact geologies of tilted and uplifted, Archean to Paleoproterozoic supracrustal rocks that constituted the upper part of the Vredefort impact target-rock sequence. Important impact features viewable in the collar rocks include such shock-metamorphic indicators as shatter cones, multiply-striated joint surfaces, and high-temperature and -pressure mineral polymorphs, together with larger scale impact-related folding, jointing, and faulting. In the core of the dome, seen at stops #13–26, the focus is on the pre- to post-impact metamorphic histories of the deep-seated, Archean crustal basement target rocks that are now exposed due to impact-related uplift and post-impact erosion. Several stops visit spectacular quarry exposures of sub-crater pseudotachylitic breccia and discuss current hypotheses and problems

regarding its origin. At several other stops, exposures of the Vredefort granophyre, which is a crater-derived melt rock with geochemical evidence of a meteoritic component, are highlighted. The guide is concluded by a thorough bibliography listing most of the key references to important previous studies of the Vredefort structure and its impact origin.

Although the guide will fill an important niche generated by the opening of the Vredefort World Heritage Site visitor center and concomitant increase in regional geotourism, it also contains a rigorous, up-to-date summary of ongoing impact and metamorphic research being conducted at the dome. More than an excellent visitor's guide to the dome, it is also a valuable reference book for readers interested in the Vredefort impact structure and its larger geologic context. With the included background sections on shock metamorphism, impact processes, geochemistry, and modeling, the guide is really a "must have" for anyone interested in the geologic effects of large extraterrestrial impact events.

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