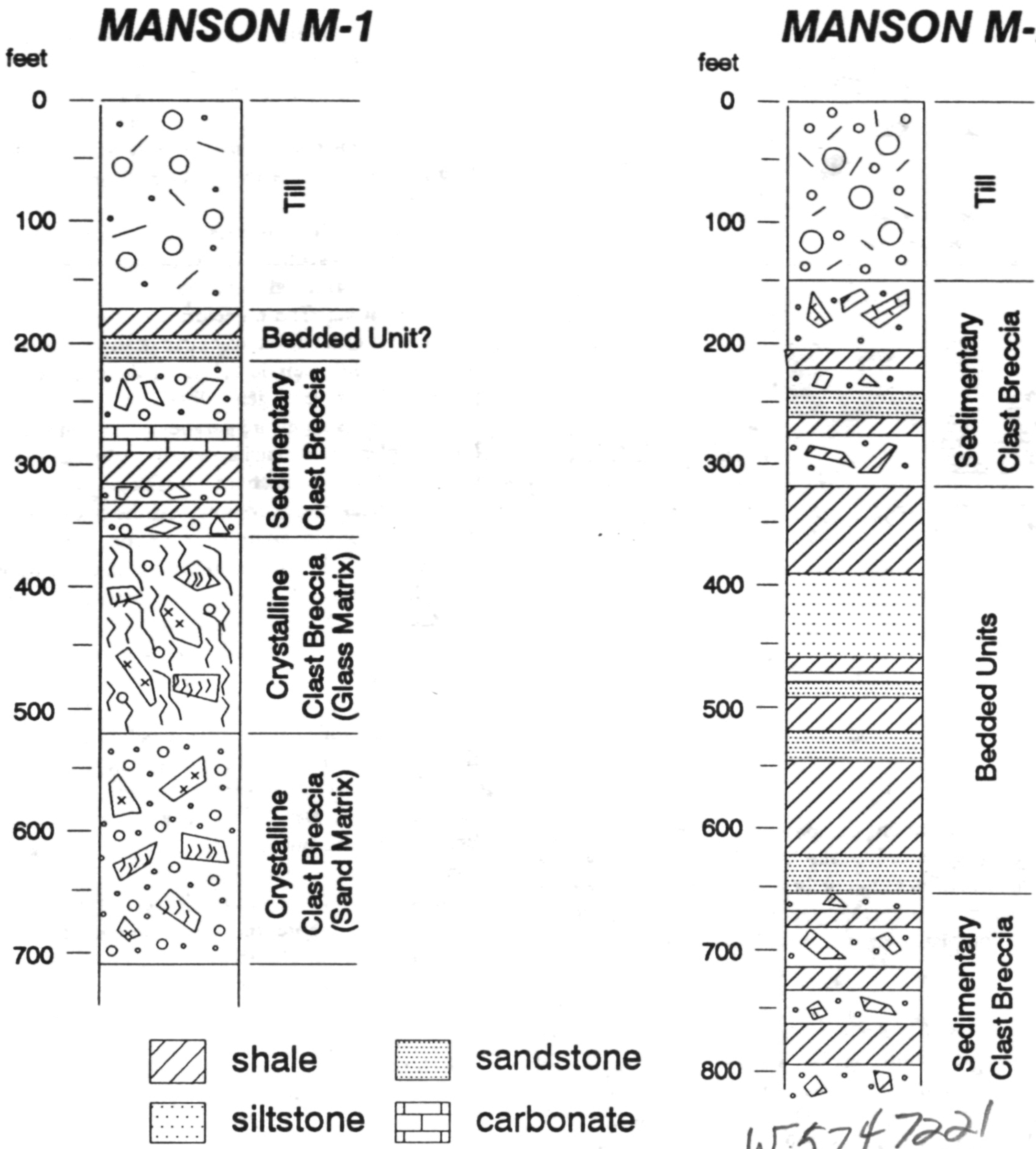

Fig. 2. Generalized lithologic logs of the Manson M-1 and M-2 cores.

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basal unit in the core was another sequence of sedimentary clast breccia, 51 m thick, and similar to the upper interval in the core. The two sedimentary clast units, like the lithologically similar unit in the M-1 core, probably formed as debris flows from the crater rim. The middle, nonbrecciated interval is probably a large, intact block of Upper Cretaceous strata transported from the crater rim with the debris flow. Alternatively, the sequence may represent the elusive postimpact lake sequence.

Additional drilling is planned for the late spring and summer of 1992. Targets include structurally preserved Upper Cretaceous strata on the Terrace Terrane, a zone of complete melting, and postimpact lake sediments in the Crater Moat.

Reference: [1] Kunk M. J. et al. (1989) *Science, 244,* 1565–1568.

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A QUASI-HERTZIAN STRESS FIELD FROM AN INTERNAL SOURCE: A POSSIBLE WORKING MODEL FOR THE VREDEFORT STRUCTURE. L. A. G. Antoine[1], W. U. Reimold[2], and W. P. Colliston[3], [1]Department of Geophysics, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa, [2]Economic Research Unit at the Department of Geology, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa, [3]Department of Geology, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa.

The Vredefort structure is a large domal feature approximately 110 km southeast of Johannesburg, South Africa, situated within and almost central to the large intracratonic Witwatersrand Basin.

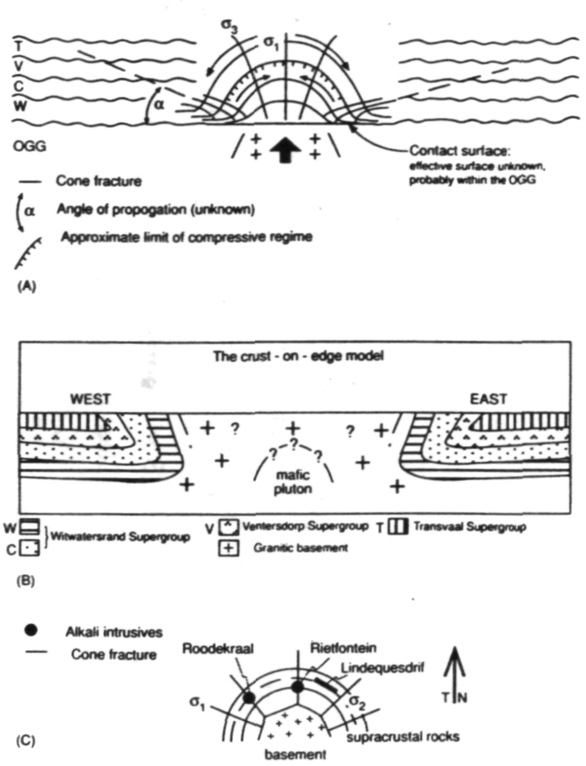

Fig. 1. Schematic illustrating a diapiric quasi-Hertzian stress field as a possible working model for the Vredefort structure: (a) predeformation cross section showing the quasi-Hertzian stress field, (b) postdeformation cross section (the crust-on-edge model), and (c) postdeformation plan view with superimposed stress field.

This structure consists of an Archean core of ca. 45 km in diameter, consisting largely of granitic gneiss, surrounded by a collar of metasedimentary and metavolcanic supracrustal rocks of the Dominian Group, Witwatersrand and Ventersdorp Supergroups, and Transvaal Sequence (for geological descriptions see, e.g., [1]).

The interpretation of images of the gravity and magnetic fields over Vredefort has permitted the delineation of several important features of the structure and of its immediate environment [2]. The polygonal, concentric outline of the collar strata is a prominent feature of both the gravity and the magnetic fields. The Vredefort structure shares this distinctive geometry with other structures (e.g., Manicouagan, Decaturville, Sierra Madera) of debated impact origin. In all these, successively older strata with steep outward dips are encountered while traversing inward to the center of the structure. A further attribute of these structures is the shortening of the outcrop of a particular stratigraphic unit compared to the original perimeter of that unit.

To account for the geometric attributes of the Vredefort structure a mechanical scheme is required where there is radial movement of horizontal strata toward, with uplift in, the center of the Vredefort structure. Two models can be proposed: (1) one in which there is a rapid rise and violent disruption of cover rocks in response to expansion of a fluid accumulation [3] and (2) one in which there is, in contrast, a nonexplosive, quasi-Hertzian stress field resulting from a diapiric process. Both models can accommodate the geometry and structural components of Vredefort. The proponents of the former model, for the Vredefort case, argue that it could provide a mechanism for deformation phenomena widely regarded as evidence of shock metamorphism (pseudotachylite, quartz with planar microdeformations, and shatter cones). Conversely, these same deformation phenomena are currently being debated [4,5] and it has been hypothesized that they could be formed by high-strain tectonic processes.

In Fig. 1, a Hertzian stress field is sketched (after [6]), both in plan- and cross-section. The stress component σ_3 is compressive, while σ_1, the principal component, is tensile and subparallel to the overlying strata. The trajectories of these stress fields can well account for overturning of collar stratigraphy and the subvertical attitude of the gneissic fabric in the core. In the collar rocks pseudotachylite veins generally occur along bedding plane faults, while in the core they are parallel to the principal shear directions [78]. In plan, σ_1 is tensile radially, whereas the intermediate σ_2 component is a "hoop stress." It is noteworthy that the lineaments of geophysical images comply with the σ_1 orientation and the triad of alkali granitic complexes (Roodekraal, Rietfontein, and Lindequesdrif), intruded into the collar, describe an arc similar to the σ_2 hoop stress. The location of these intrusives could be at the intersection of the σ_1, σ_2 tensile stress components.

This postulated quasi-Hertzian deformation model is dynamic, so the contact stress and resultant strain would be expected to be complex and to modify in time (see, e.g., [9]). Within the compressive regime (which may have a radius as much as the contact diameter of the indentor, in this case the diapir) [8,9] the σ_1 stress component is compressive and may account for the radial inward riding of sedimentary strata. The observed polygonal geometry results from the outward rupture and relative brittle strain of overlying strata outside the compressive regime (Fig. 1a).

In conclusion, the geometric and structural attributes of the Vredefort structure are consonant with a quasi-Hertzian stress field. In particular, it corroborates the many observations of ubiquitous subhorizontal structures that have led investigators to deduce that the Vredefort structure was produced by subhorizontal forces (see, e.g., [8,10]).

References: [1] Hart R. J. et al. (1991) *Tectonophysics, 182*, 313–331. [2] Antoine L. A. G. et al. (1990) *Tectonophysics, 171*, 63–74. [3] Nicolaysen L. O. and Furgeson J. (1990) *Tectonophysics, 171*, 303–335. [4] Antoine L. A. G. and Reimold W. U. (1988) *Global Catastrophes in Earth History*, 2–3, LPI Contrib. No. 673. [5] Reimold W. U. and Wallmach T. (1991) *S. A. J. Sci., 87*, 412–417. [6] Lawn B. R. and Willshaw E. (1975) *J. Mater. Sci., 10*, 1049–1081. [7] Reimold W. U. and Colliston W. P., this volume. [8] Colliston W. P. and Reimold W. U., this volume. [9] Bahat D. (1980) *J. Geol., 88*, 271–284. [10] Colliston W. P. (1990) *Tectonophysics, 171*, 115–118.

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SUDBURY PROJECT (UNIVERSITY OF MÜNSTER–ONTARIO GEOLOGICAL SURVEY): (6) ORIGIN OF THE POLYMICT, ALLOCHTHONOUS BRECCIAS OF THE ONAPING FORMATION.

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The Sudbury structure has been interpreted as a deeply eroded remnant of a peak-ring basin [1]. The polymict, allochthonous breccias of the Onaping Formation (OF) occur in the central part of the Sudbury structure, which is surrounded by the 1.85-Ga-old [2]