Memorial to Robert Hargraves 1928–2003

TULLIS ONSTOTT
Princeton University, Princeton, New Jersey 08544, USA

Robert Hargraves, or Rob as we knew him, died on March 21, 2003. Rob was a member of Princeton University’s Department of Geosciences faculty from 1961 to his retirement in 1994. He is survived by his wife, Sybil, his three daughters, Monica, Allison, and Colleen, three sons-in-law, John, Andrew, and John, and four grandchildren. Rob was internationally known for his contributions to geologic and geophysical problems dealing with the full span of Earth’s 4.5 billion year history, as well as for studies of the Moon and Mars. He was one part “magnetic petrologist,” one part “planetary tectonicist,” and one part “impactologist,” but was perhaps best known for his nonconformist view of Earth’s history.

He was born on August 11, 1928, in Durban, Natal, South Africa. He received a B.Sc. Honors at the Natal University College in Geology and Chemistry in 1948. After spending a few years as an exploration geologist in southern Africa, he moved to the United States in 1952 to work for Newmont Mining Corporation. He was soon drafted for service in the U.S. Army, and following his discharge in 1956, he entered graduate school at Princeton University, where, under the guidance of A.F. Buddington, he combined a new technique, paleomagnetism, with petrology to determine the tectonic history of the Precambrian anorthosite and hemoilmenite deposits at Allard Lake, Quebec. After receiving his Ph.D. in 1959, he completed a postdoctoral fellowship at the University of the Witwatersrand, South Africa, and then returned to the United States to join the faculty at Princeton University.

During this stint in South Africa, Rob discovered shatter cones in the basement outcrops near the farm town of Vredefort. He recognized their significance and was one of the first to attribute the origin of the 2.0 Ga, 80 km diameter, Vredefort ring structure to a major meteorite impact, the oldest and largest recognized at that time (Hargraves, 1961). His interpretation diametrically opposed the “cryptoexplosion” explanation for Vredefort and other circular structures that prevailed in South Africa then, and it wasn’t until the late 1980s that the Vredefort’s impact origin finally became accepted.

Rob was also one of the early pioneers of paleomagnetism in both sedimentary (Hargraves and Fischer, 1959) and igneous rocks (Hargraves, 1959). As an ardent supporter of continental drift and, later, plate tectonics, Rob enthusiastically applied paleomagnetism to a myriad of tectonic problems spanning the geological time scale and four continents. Rob and his many Ph.D. and undergraduate students accompanied him to some of the more exotic and challenging locales with rock drill in hand. His work in the northern Andes and coastal ranges of South America and the Caribbean culminated in a comprehensive regional plate tectonic model (Duncan and Hargraves, 1984). Rob was forever returning from Niger, Sierra Leone, Burundi, Seychelles, British Guyana, India, and South Africa with oriented rock samples. His results delineated apparent versus true polar wander for Africa (Hargraves et al., 1987) and placed constraints on the origin of African
Proterozoic mobile belts and Precambrian Paleogeography, for which he received the prestigious Jubilee Medal of the Geological Society of South Africa in 1987.

Rob’s most significant contributions to the field of paleomagnetism, however, can best be summarized as “magnetic petrology.” Rob fervently believed that understanding the petrology, magnetic mineralogy, geochronology, and thermal history of the rock formation was as important to interpreting the paleomagnetic remanence as determining its direction and stability. His early findings that crystalline anisotropy of hemoilmenite can drastically deflect the direction of TRM from that of the applied field taught Rob that highly stable remanent magnetism by itself was not necessarily proof of accurate paleofield determination. He often stated that “the devil is in the details” and he felt strongly that the field could only advance by honest appraisal of the source of paleomagnetic remanence. The origins of anorthosite, both terrestrial and Lunar, and its remarkably stable remanent magnetism was a focus for many of his studies (Hargraves and Hollister, 1971), but Rob also explored the mineralogical and petrological foundations of the stable remanent magnetism in mafic intrusions (Hargraves and Young, 1969), basalts (Hargraves and Ade-Hall, 1974), red beds, kimberlites (Hargraves and Onstott, 1980), meteorites (Banerjee and Hargraves, 1971), Lunar rocks (Hargraves and Dorety, 1971) and even Martian dust.

Thanks to Rob, the Viking landers carried magnets, which led to his discovery that Martian dust was highly magnetic (Hargraves, Collinson and Spitzer, 1976). For this he received the NASA Medal for Exceptional Scientific Achievement in 1977. His observations defied the conventional wisdom held by NASA geologists that Martian dust was simply finely comminuted volcanic rock or ash. Through a series of publications, he explored various alternative explanations for this perplexing property (e.g., Moskowitz and Hargraves, 1982). Later, during the Martian pathfinder mission, Rob, with his Danish colleagues, was able to demonstrate that the ubiquitous, highly magnetic dust must be providing clues to the evolution of the Martian climate (Hargraves et al., 2000).

Some of Rob’s most creative ideas concerned global tectonics. During the early 1970s, when isotope geochemists were just beginning to place constraints on the growth history of continental crust, Rob became intrigued by the tectonic implications of this accumulation record. Rob wrote a series of papers on Precambrian tectonics and the geodynamic evolution of the Earth (Hargraves, 1976; 1978; 1981; 1986). His “liberal uniformitarian” perspective on the Precambrian geological record again brought him into conflict with his colleagues, who confidently extrapolated the relatively new plate tectonic paradigm deep into the Precambrian with little concern about the temporal variations in heat flow, crustal dichotomy, crustal composition, and free board. His proposal that the Archean earth was entirely covered by ocean, his observations regarding elevated tidal currents in the Proterozoic (Hargraves, 1970), his work showing the relationship of the diamantiferous kimberlites to mantle hotspots (Crogh et al., 1980), his “Mantle roll” hypothesis (Hargraves and Duncan, 1973), and his demonstration of how the modern plate tectonic model would have to function in the Archean, may have been controversial, but they were always thoughtful and provoking. Rob took great pleasure in thinking outside of the accepted paradigms and relished exposing the “jokers in the wood pile”—those untestable or untenable assumptions often left hidden.

During that latter part of his career and thirty years after that initial discovery of shatter cones near Vredefort, South Africa, Rob was doing some consulting work near the Montana/Idaho border when his keen eyes spotted shatter cones in Precambrian outcrops! Thus was discovered a relict of an impact structure that was at least 60 km in diameter, subsequently christened the Beaverhead impact structure (Hargraves et al., 1990). Over the subsequent decade, Rob, with many students, colleagues, and friends, published on its various attributes (Fisk and Hargraves, 1998).

The day before he entered the hospital for what was to be his final visit, he was busily working on a new type of remanent magnetism with major implications for unraveling tectonic histories and an Archean iridium anomaly newly discovered in South Africa. To the very end, Rob’s thirst
for doing science was unslakeable. Rob Hargraves has left us with a legacy of wonderfully unique observations about the history of Earth, the Moon, and Mars. For this and his many contributions to the geology of southern Africa, Rob was posthumously awarded an Honorary Member of the Geological Society of South Africa. For many of us, his most important legacy, however, was the enthusiastically articulate and unabashedly honest style with which he made and reported these observations.

SELECTED BIBLIOGRAPHY OF ROBERT HARGRAVES

1986 Faster spreading or greater ridge length in the Archean?: Geology, 14, p. 750–752.
