BullsEye Earth!

Graeme Addison tells why the little-known Vredefort impact zone—site of the world's oldest and biggest meteorite strike—is being proposed as a World Heritage site. (This article was first published in *Popular Mechanics* before the declaration of the Dome WHS by Unesco in 2005).

Fears that a wandering asteroid or comet could cross earth's path and destroy life as we know it are not unfounded—it's nearly happened a couple of times in recent years. But bombardment by meteorites (meteors that actually hit the ground) has also benefited mankind. What most people do not know is that the world's oldest and largest impact crater sits in the heart of South Africa, centred on the sleepy Free State dorp of Vredefort. And it is this "astrobleme" (eroded crater) that South Africa has to thank for first preserving, then exposing, the mineral riches of its gold-bearing reefs.

The hit occurred some 2.02 billion years ago, before multi-celled life evolved on this planet. It forced the rocks of the Witwatersrand basin deeply downwards, protecting them from erosion, so that finally when prospectors arrived on the scene in the 1870's they were fortunate to find traces of gold on one of the upturned edges of the basin, which had by now broken the surface. Johannesburg, the mining and financial powerhouse of Africa, was born.

ASTEROID

The Vredefort Ring is one of the largest natural disaster features on earth and has been photographed by Nasa astronauts in the Space Shuttle. It's a regular BullsEye seen from space, but you don't have to put down $20million like Mark Shuttleworth to see the crater for yourself. A short drive south of Johannesburg on the N1 takes you over the Grasmere ridge which is one of the concentric rings that registered the force of the impact, like ripples spreading from a stone dropped in a puddle.

Closer to the Vaal river the ridges get higher, and overlooking the river itself in the vicinity of Parys are several hump-backed bush-clad mountains known as Die Bergland. Whitewater rafters who run the rapids of Parys, and mountain-bikers tackling the championship courses of Bergland have the meteorite to thank for turning what would otherwise be flat mielielands into rugged hills and tumbling rapids. Because the meteorite at an angle from the southeast it pushed up the northwestern edges rather like a crumpled carpet, and along these northwestern edges today are the mines of the central

and western Witwatersrand. But the circle extends right around to the south where other gold mines operate at Welkom.

Of the asteroid itself there is little or no trace: it probably vaporized, but is likely to have been a wandering asteroid at least the size of Table Mountain. Drawn in by the earth's gravity, it blasted the surface with a detonation equivalent to millions of nuclear bombs. The crust down to about 25km melted and a mass of magma welled up, forming a vast granite bubble or dome (so the place is widely known as the Vredefort Dome).

The existing ridges are no more than the stumps of the once mighty dome perhaps 7km high—nearly as high as Everest today—that ballooned upwards from the cauldron and immediately collapsed. Today a small pan near Vredefort called Die Inlandsee is much favoured by passing flocks of flamingos, and this is the dead centre of the impact zone that has now appeared at the surface due to aeons of erosion.

AGED WATERCOURSES

It is arguable (but speculative) that the generally placid Vaal River is one of the world's oldest watercourses, if not the oldest. In the era when the Witwatersrand basin was formed the supercontinent of Gondwanaland consisted of Southern Africa, India, Madagascar, Australia, Antarctica and South America. In the middle was a vast flat lake where sand and pebbles settled down in strata, carrying gold and other minerals in powdery grains. As Gondwanaland split apart like a mighty jigsaw all that was left was Southern Africa with its central basin, drained by rivers being the predecessors of the Orange-Vaal watershed.

The Vredefort crater, estimated at 300km in diameter, is one of three known massive impact sites amongst many hundreds or even thousands of meteorite blemishes on the earth. The other two really large sites are at Sudbury in Ontario, Canada, and Chicxulub on Mexico's Yucatan Peninsula. The Sudbury area has the dubious record of being the target area of two major hits: the first, almost as ancient as Vredefort, causing a 200km-wide crater, and the second a smaller one just 37 million years ago.

The most celebrated crater is Chicxulub (pronounced CHEEK-shoe-lube), for this impact was almost certainly the cause of the extinction of the dinosaurs about 65 million years ago, a catastrophe that extinguished up to two-thirds of all animal and plant species and could easily happen again unless we keep our wits about us. Today the crater extends into the Caribbean Sea across a diameter of 180km. Oil prospectors first spotted it as a rather peculiar irregularity in the rock formations, which are characterized by typical "shatter cones" (triangular shapes) caused by intense shocking of the rock. Shatter cones are found in profusion on the remains of the Vredefort impact too.

There was a period about four billion years ago when the earth, like the Moon, was subjected to a steady bombardment of asteroids and comets that pocked the land extensively. The fact is that asteroids or comets can and do hit the earth and if we should ever have another one this size it would certainly wipe out all life. Task forces have been appointed both in Britain and the United States to track down near-earth objects and lay plans to neutralise them if possible. Nasa has a substantial programme and has been set a goal by Congress to detect at least 90 percent of all near-earth objects with a diameter greater than one km within 10 years.

Up to 10000 meteorites hit the earth every year, but they are generally no larger than a grapefruit and often as small as a pea, so they go unnoticed. A larger impact occurs perhaps once in 100 000 years, a very large one every couple of million years. The probability of a gargantuan strike like Vredefort is remote, but probabilities are not predictions and one could threaten at any time. The effects of the earth being hit by an asteroid bigger than one kilometre in size would be devastating, with a blast and dustcloud likely to cause climate change and rapidly cut off food supplies. Millions of human beings could die—if not all of us, depending on the severity of the event.

Everything you have seen on the wide screen in Hollywood films like “Deep Impact” could come true, so it is no wonder plans are being laid to launch nuclear warheads into space to deflect any menacing lumps of rock or ice. But don’t breathe easier just yet. Several large space bodies have passed close the earth in recent years without anyone noticing until it was too late.

As for the Vredefort Dome, it happened so long ago that only the barest traces remain. We do not know what effect it had on the very simple single-celled lifeforms that seem to have been evolving at the time. Its importance as the oldest and biggest known impact zone, and the golden heritage it has left us, are ample justification for the effort now being made through the SA Department of Environmental Affairs and Tourism to have the Vredefort Dome declared a World Heritage Site by Unesco.

- Graeme Addison lives in Parys where he is researching and writing a book on the Vredefort Dome & Vaal River valley. The article may be quoted with acknowledgment to the author. First published in *Popular Mechanics.*