THE STEEN RIVER IMPACT STRUCTURE, ALBERTA, CANADA. A.R. Hildebrand[1], M. Pilkington[1], R.A.F. Grieve[1], R.R. Stewart[2], M.J. Mazur[2], D.W. Hladiuk[3], and D. Sinnott[3], [1]Geological Survey of Canada, Ottawa, Ontario, K1A 0Y3, Canada, [2]Department of Geology and Geophysics, University of Calgary, Calgary, Alberta T2N 1N4; [3]Gulf Canada Resources Ltd., Calgary, Alberta T2P 2H7, Canada.

The ~25 km-diameter Steen River impact structure, (59° 30' N, 117° 38' W) is the remnant of the largest known impact crater in the Western Canadian Sedimentary Basin (WCSB). The eroded crater lies buried under ~200 m of cover with no surface expression, necessitating geophysical and drilling projects for its exploration. In this area the WCSB is composed of ~1 km-thick gently SW-dipping strata. The crater rim hosts seasonal petroleum production of ~600 BOPD and shut-in gas wells, stimulating continued searches for hydrocarbon reservoirs in the impact structure. Although Steen River was discovered more than thirty years ago with documented evidence of shock metamorphism (e.g., 1, 2), little has been published about it.

Hydrocarbon exploration companies have acquired more than one hundred 2-D seismic reflection profiles over the impact structure, and one 3-D seismic survey was recently executed over part of the crater rim. Approximately forty wells have been drilled in and near the crater, providing generally good control for the coherent seismic data. The proprietary seismic data outline the rim uplift of the impact structure in some detail, but most profiles record only chaotic reflectors interior to this. Mapping the crater's interior structures has been attempted with magnetic- and gravity-field surveys. An aeromagnetic survey with 0.5 km line spacing has recently been flown across the entire structure (Fig. 1), revealing large amplitude central and concentric anomalies. A pilot gravity survey revealed associated anomalies with a maximum value of ~3 mGal, slightly smaller than that expected for a crater of this size (3). Positive anomalies of up to ~0.5 mGal were found associated with the rim uplift. A total of ~1,500 gravity stations have now been acquired over the crater. Interpretation of the gravity data is complicated by the high regional gradients (17 mGal decreasing NWwards across the impact structure), with super-imposed regional anomalies of 10 to 20 km scale.

Rim uplift, down-slumped blocks and the central uplift are well to partly delineated. Well 16-19 records the inverted stratigraphy of the overturned flap, lying on the inner down-slumped blocks, and establishes a minimum structural downdrop of ~0.6 km. Only minor relief is indicated on the unconformity developed on the top of the impact lithologies. Rim erosion of ~1 km is indicated by the amount of extra stratigraphy preserved in the slumped blocks in well 16-19 in the crater's interior, and assumption of a rim-to-crater-floor depth of 0.5 km. This erosion has presumably subdued the crater's gravity expression. Reflection seismic data usually have not detected the down-slumped blocks, but occasionally provide vague images, and a slump zone at least 3 km wide is indicated. Wells and seismic profiles reveal an irregular, faulted, crater perimeter with rim uplift of up to ~100 m. The central structural uplift has a radius of ~3 km, based on well control and magnetic-field anomalies; substantial asymmetry may occur in the central uplift and slump zone. Well 12-19 penetrated the central structural uplift immediately below the Cretaceous cover at a depth of 184 m, establishing a minimum structural uplift of ~1100 m relative to the surrounding basement surface. Large-amplitude magnetic anomalies are also preserved adjacent to and detached from the central uplift; these may represent remnants of intracrater melt rocks and/or suevitic breccias.

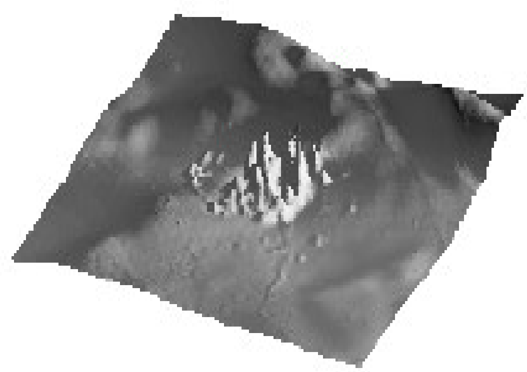

Fig. 1. Total magnetic-field intensity over Steen River impact structure. Compare short wavelength crater anomalies to broader regional anomalies.

References: (1) Carrigy, M.A. and Short, N.M. (1968), in Shock Metamorphism of Natural Materials, French, B.M. and Short, N.M., eds. (Mono Book Corp., Baltimore, MD), 367-378; (2) Winzer, S.R. (1972) 24th Inter. Geol. Cong., Planet., Sect. 15, 148-156; (3) Pilkington, M. and Grieve, R.A.F. (1992) Rev. Geophys., 30, 161-181