A RECONSIDERATION OF AN IMPACT MODEL FOR THE RIES CRATER BASED ON COMPARISONS BETWEEN THE RIES-STEINHEIM AND CLEARWATER LAKE PAIRED CRATERS.

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**Introduction:** Terrestrial impact craters provided examples of craters of different sizes formed in a broad range of target materials ranging from crystalline rocks to stratified sedimentary rocks with variable physical properties. There are corresponding variations in the structure and topographic expression of the craters: those formed largely or entirely in crystalline rocks show morphological similarities to craters formed on other rocky planets while those where sedimentary rocks predominate comprise a subset not readily matched elsewhere in the Solar System. Steinheim crater[1], the smaller 3.4km diameter companion to the Ries, is representative of complex craters formed in sedimentary rock targets that have a central uplift that has risen from a depth (d) approximately 1/10th the diameter (D) of the final crater. A general expression d = 0.086 D^{1.03} has been derived from these craters[2]. As the central uplift has typically risen to within 50-100m of the original surface, d has also been accepted as the approximate depth of the excavated transient cavity (or primary crater) prior to any late stage modification. However drilling at the 3.8km Brent simple crater formed in crystalline rocks shows a transient cavity depth of about 1km [3], about three times that for Steinheim. From a consideration of shock metamorphism in the central uplifts of larger crystalline rock craters an alternative expression d = 0.4 D^{0.84} has been developed [4]. As the 24km Ries crater is formed in a mixed target of sedimentary rocks ~700m thick overlying a crystalline basement the question of which formula is more appropriately applied in such a case is open.

**Current Ries model:** Pohl et al. [5] provide a model of the Ries crater based on geological, geophysical and drilling information available in 1977 that appears to remain the current standard. It infers that the crater has a relatively subdued central peak 4 to 5km in diameter that may in part rise to within ~500m of the surface, has significant magnetic expression, and may be covered by 100 to 400m of suevite breccia as found in the Nördlingen drillhole of 1973. The hole was placed 3.5km from the center and thus outside the inferred central peak. The primary crater (transient cavity) is estimated to have been 2 to 3 km deep, apparently by using the sedimentary crater formula. Interpretations of seismic and gravity data indicate that fracturing of the underlying basement extends to a depth of 6km. Note, however, that fracturing at Brent largely dies out within about 150m of the base of the transient cavity.

**The Clearwater Lake paired craters:** The two craters at Clearwater Lake, northern Quebec, [6] bear comparison with the Ries-Steinheim pair, being also about 40km apart (center to center), though their larger size (32 and 18-20 km) brings their rims closer together. They were formed in crystalline rocks overlain by an estimated 50-100m of Paleozoic limestone 275Ma ago and have been eroded by approximately 500m since formation. The larger West crater resembles the Ries in having a topographically subdued central peak with a significant magnetic signature and a distinct ring uplift half the diameter of the final crater but has a weaker gravity ano-