THE IMPACT OF RIES CRATER RESEARCH ON THE RECOGNITION AND CLASSFICATION OF IMPACT-METAMORPHOSED PLANETARY ROCKS. D. Stöffler[1] and W. U. Reimold[1], [1]Museum für Naturkunde – Leibniz Institute at the Humboldt University Berlin, Research Department / Mineralogy Section, Invalidenstrasse 43, D-10115 Berlin, Germany; dieter.stoeffler@mfn-berlin.de

Introduction: The Ries crater (Ø = 25 km) is the best preserved and best studied mid-sized complex terrestrial impact crater formed in a target with ~ 700 m of Mesozoic sedimentary rocks on top of crystalline rocks. The 14.35 m.y. old [1] crater displays an uplifted inner ring and a two-layer ejecta blanket with a discontinuous layer of suevite on top of a continuous polymict megabreccia (“Bunte breccia”) [2].

Five decades of Ries research: Modern research prompted by the discovery of coesite in 1960 [3] has been continuous, intensive, interdisciplinary, and international within 5 decades. It has been repeatedly stimulated by progress in the exploration of terrestrial planets, but it also fostered related studies of other cratered landscapes and impact-metamorphosed rocks.

Major messages from Ries research: Studies of the Ries crater and its rocks have been fundamental for many outstanding issues of planetary impact cratering research. The most conspicuous issues are: (a) Properties, geological setting, stratigraphy, and classification of allochthonous and autochthonous impact formations including distal ejecta (tektites) [4,5,6,7]. (b) Recognition and systematics of progressive shock metamorphism of rocks [8,9] including the identification and geologic setting of metastable high pressure minerals [e.g., 10,11,12]. (c) Discovery and interpretation of impact-induced geophysical anomalies [4,5,6]. (d) Ground-truth for the model of secondary mass wasting on planetary surfaces induced by the ejecta deposition [13]. (e) Ground-truth for post-impact hydrothermal activities in “hot” impact formations such as suevite with applications to Mars (14,15). (f) Recognition and genesis of different types of suevite [6,16] and most recent attempts for a new genesis of suevite by “quasi-phreatomagmatic” explosions based on the concept of “fuel-coolant”-interaction [17]. (g) Modern quantitative structural geology of impact craters [18].

Currrent systematics of planetary impactites: Ries crater studies have been instrumental for the development of a comprehensive classification and nomenclature of (1) impact-induced rock types (impactites), and (2) progressive shock metamorphism of rocks including meteorites [19,20,21,22]. Earlier classification attempts were taken up by the IUGS Subcommisssion on the Systematics of Metamorphic Rocks [9,23]. The IUGS proposal applicable to all terrestrial planetary bodies, involves: (1) Impactites from single impacts, and (2) impactites from multiple impacts. Type 1 is subdivided into “proximal” and “distal”. Proximal impactites are: (1) Shocked rocks, (2) impact melt rocks, and (3) impact breccias. Impact breccias are subdivided into (3.1) monomict breccias, (3.2.) lithic breccias (without cogenetic melt particles), and (3.3.) suevite (with cogenetic melt particles) with 3.2 and 3.3 being polymict breccias.

Conclusion: For future sampling activities of astronauts or robots on planetary bodies it appears mandatory to educate them on macroscopic properties of terrestrial impactites and their parental craters.

References: [1] Buchner E. et al. (2003), *Int. J. Earth Sci. Geol. Rund. 92*, 1-6. [2] Stöffler, D. and Ostertag, R. (1983) *Fortschritte Mineralogie 61, Bh 2*, 71-116. [3] Shoemaker, E.M. and Chao, E.C.T. (1961), *JGR 66*, 3371-3378. [4] Pohl, J. et al. (1977) in Roddy, R.O. et al. (eds.) Impact and Explosion Cratering, Pergamon Press, N.Y., 343-404. [5] Bayer. Geol. Landesamt (ed.) (1969) *Geologica Bavarica 61,* 478 pp. [6] Bayer. Geol. Landesamt (ed.), (1977) *Geologica Bavarica 75,* 470 pp. [7] Engelhardt, W. v. (2005) *Geochim. Cosmochim. Acta 69*, 5611-5626. [8] Stöffler, D. (1971*) JGR 76,* 5541-5551. [9] Stöffler, D. and Grieve, R.A.F. (2007) in Fettes, D. and Desmons, J. (eds.) *Metamorphic Rocks,* Cambridge Univ. Press, 82-92, 111-125, and 126-242. [10] Schmitt, R. et al. (2005) in Kenkmann et al. (eds.) *Geol Soc. of America Special Paper 384*, 299-314. [11] El Goresy et al. [2001] *Science 293*, 1467-1470. [12] Stähle, V. et al. (2010) Contrib.Min.Petrol, in press. [13] Hörz et al. (1983) *Rev. Geophys. Space Phys. 21*, 1667-1725. [14] Newsom, H. E. et al. (1986) *JGR 91, B13,* E239-E251. [15] Muttik et al. (2008) *Meteoritics & Planet. Sci., 43,* 1827-1840. [16] Stöffler, D. et al. (2009) *LPS XL,* Abstract #1504. [17] Artemieva, N.A. et al. (2009) *LPS XL,* Abstract #1526. [18] Kenkmann, T. and Ivanov, B.A. (2006) *EPSL, 252*, 15-29. [19] Stöffler, D. et al. (1980) in Papike J.J. and Merrill, R.B. (eds.) *Proc. Conf. Lunar Highland Crust*, Pergamon Press, N.Y., 51-70. [20] Stöffler, D. et al. (1991) Geochim. Cosmochim. Acta *55*, 3845-3867. [21] Stöffler, D. et al. (2006) and [22] Hiesinger, H. and Head, J. (2006) both in Joliff, B. L: et al. (eds.), *New Views of the Moon, Rev. Mineral. Geochem., 60,* Mineral. Soc. America, 519-596 and 1-81, resp.. [23] Fettes, D and Desmons, J., eds. (2007) *Metamorphic Rocks,* Cambridge Univ. Press, 244 pp.