SHOCK METAMORPHISM OF ZIRCON IN NATURE AND EXPERIMENT: A REVIEW A. Gucsik[1] (ciklamensopron@yahoo.com), Sz. Bérczi[2], Á. Kereszturi[2], H. Hargitai[2] and Sz. Nagy[2], [1]University of West Hungary, Bajcsy-Zs. u. 4., Sopron, H-9400, Hungary; [2]Eötvös Loránd University of Budapest, H-1117 Budapest, Pázmány Péter sétány 1/c., Hungary,

Introduction: Zircon is a highly refractory and weathering-resistant mineral that has proven useful as an indicator of shock metamorphism in the study of impact structures and formations that are old, deeply eroded, and metamorphically overprinted [1-4]. Zircon has advantages compared to quartz or other shock-metamorphosed rock-forming minerals that have been widely used as impact indicators, but are far less refractory than zircon. Furthermore, U-Pb dating of zircon can provide constraints on the ages of impact events or deposition of impact formations [5,6].

Shock metamorphic effects in zircon. Shock-induced microdeformations in zircon have been described from a number of impact environments including confirmed impact structures [2,3,7-10], the Cretaceous-Tertiary boundary, and the Upper Eocene impact ejecta layer [1,7,9], as well as from tektites [9,11]. Shock-induced microdeformation in experimentally shock-deformed zircon crystals has also been reported [6,12,13].

Two different types of shock deformation have been observed: (i) planar microdeformation and (ii) the granular (also called polycrystalline, microcrystalline, (strawberry) texture. Some effort, especially by transmission electron microscopy (TEM), has been made to determine whether the planar microdeformations discernable at the optical scale in shock-metamorphosed zircon represent bona fide planar deformation features (PDFs), well-known from many other shock-metamorphosed rock-forming minerals [14-16], or whether they represent planar fractures or some other type of microdeformation [4]. To date, this problem has not been solved. Leroux et al. [12] established that, on a nanometer scale, amorphous phases in the form of planar lamellae were formed in zircon experimentally shocked at 40 and 60 GPa. However, these authors were unable to confirm that these micro-lamellae, though resembling PDFs, indeed corresponded to the optically resolved, several µm wide, planar/subplanar microdeformations. Leroux et al. [12] also observed numerous planar fractures and dislocation deformation bands. It can not be excluded that these features correspond to the optically resolved planar microdeformations.

The granular texture in zircon was first observed by Bohor et al. [1] from the Cretaceous/Tertiary distal impact ejecta layer. Since then, it has been observed in a number of impact structures [2,5], in zircon from a Late Eocene microkrystite layer, and in tektites [9,11]. Baddeleyite as a result of thermal decomposition of zircon (T >1676 ^{o}C) has been identified in impact-generated rocks [17,19] and has been quoted as evidence for the impact origin of these enigmatic glasses. According to Reimold et al. [4], the granular shock texture has been interpreted as the result of recrystallization of zircon to aggregates of smaller crystals in response to high temperatures induced by the shock process.

The phase transformation from the zircon crystal structure ($ZrSiO_4$) to a scheelite ($CaWO_4$)-structure phase was described in shock-metamorphosed zircon by Kusaba et al. [20] to begin at about 30 GPa and to be complete at around 53 GPa. These observations were confirmed by Leroux et al. [12] through their TEM investigations of experimentally shocked zircon. More recently, according to Scott et al. [21] the high-pressure x-ray data show that a small amount of residual zircon-structured material remained at 39.5 GPa. Glass et al. [22] found the scheelite-type phase in zircon samples from marine sediments from an upper Eocene impact ejecta layer sampled near New Jersey and Barbados. They named this mineral phase 'reidite' after Alan F. Reid, who first produced this high shock-pressure polymorph of zircon [23]. The reidite first was identified at a terrestrial impact structure such as Ries impact crater (Germany) by Gucsik et al. [24], using a combination of the Scanning Electron Microscope-Cathodoluminescence and micro-Raman techniques.

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