IMPACT METAMORPHISM OF SANDSTONES AT AMGUID CRATER, ALGERIA.

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Introduction: Amguid is a 450 m diameter and 30 m deep sample crater; it is emplaced in Lower Devonian sandstones. Uplifted sandstone strata are observed along the upper part of the crater walls. The floor of the crater is covered by alluvial deposits [1,2]. We have carried out a petrographic study of 17 samples from the crater wall collected by [2] in order to investigate shock effects recorded in these sandstones, and define shock stages in Amguid (see [3 and 4] for comparison).Two thin sections from each sample were made for petrographic observations by optical and electron microscopy. The samples reveal a wide range of shock features; they have been divided into two categories: 1) features common in quartz-rich target rocks and 2) related-porosity features and textures.

Shock effects in quartz grains: They include fracturing, ondulatory extinction, mosaicism (which are not diagnostic of shock when not associated to other diagnostic shock effects), PFs, PDFs and toasted quartz. “Planar elements” are reported by [1] without any distinction between PFs and PDFs, this distinction is, however, indispensable for the determination of the shock stages. In the present paper, we defined two sets of PFs oriented parallel to $\{1013\}$, generally decorated, and to (0001) which is non-decorated set (Brazil twins parallel to (0001) have mechanical character). PDFs are parallel to $\{1012\}$, $\{1122\}$, $\{5161\}$, $\{1010\}$, these sets are already reported by [1]. New sets of PDFs are defined in this work; they are parallel to $\{1011\}$, $\{2131\}$, $\{1121\}$ and some sets parallel to $\{1013\}$. The reduction of PDFs parallel to $\{1013\}$ might due to its suppression in favor of others (e.g. $\{1011\}$ and $\{1122\}$); this is frequent in sedimentary rocks [5]. PDFs sets are generally decorated, this indicates that Amguid crater sandstones are strongly altered. Toasted quartz is also observed in the samples, it is believed to be a post-shock feature, either resulting from the exsolution of water from glass (primaly along PDFs), or formed by vesiculation after pressure release, at high post-shock temperature and thus, represents the beginning of quartz breakdown due to heating [5].

Related-porosity shock effects: they are identified by comparing the samples inside the crater with fresh non-shocked samples forming the target rock collected outside the crater. The principal mechanism of energy deposition by a shock wave in a porous material is the reverberation of shock and rarefaction waves through grains due to collisions with other grains. The radial pattern of the concussion fractures, observed in 20% of the quartz grains, are tensile fractures formed by the impact of neighboring grains as the shock front initially traversed the material and closed pore spaces. Thus, the directions of the apparent concussion axes were measured in 3 oriented thin sections. The median value of the axial direction is about 10°. The Quartz grains shapes in samples of the crater wall are more elongated than fresh samples. The direction of elongation of quartz grains is aligned to within 15° of the median value. There is no petrographically observable porosity in these rocks, and the quartz grains interlock with one another like pieces of a jigsaw puzzle (jigsaw texture). The boundaries of the grains appear in a vermicular habit; they are yellow to gold in transmitted light and scatter reflected light. These boundaries, called symplektic regions, are composed of micron-sized, high-index crystallites isotropic areas and quartz. The isotropic areas observed in Meteor crater and Haughton are interpreted to be a mixture of microcrystalline coesite and diaplectic glass. At Amguid, the optical characteristics are consistent with this interpretation; however, quantitative X -ray diffraction is indispensible to confirm the coesite nature. Vesicular glass within opaque regions surrounding the quartz grains is also observed in some samples.

Shock stages: The occurrence of sets parallel to $\{1012\}$ and $\{1013\}$ together (without any other set) indicates the strongest shock stage established using PDFs. On crystalline rocks, this stage corresponds to class 5, while on sedimentary rocks, it corresponds to class 3a. In Amguid samples, this association has been observed on only 3 samples, they occur with symplektic regions. Thus, rocks of Amguid are shocked at pressures of 20 Gpa and temperature of 1000°. In the highest stages of shock metamorphism, PDFs disappear. Amguid’s samples are shocked at pressure of 30 Gpa (class 4), this is attested by the association of vesicular glass and symplektic regions. Our samples don’t show neither rocks of class 3b, 5b and 6 (added by Osinski from Haughton crater) [4], nor rocks of class 5a observed only on Coconino rocks of Meteor Crater [3]. We conclude that shock effects allowing determination of shock stages are closer to those of Coconino sandstones at Meteor Crater, but are not shocked to the same pressure. A systematic and refined collection of samples in Amguid may show rocks shocked to higher pressures.

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