

[10]. Then it should be clear why there are not pseudotachylites older than 2 Ga. Secondly, the low ages could be due to post-2-Ga thermal overprint. Host rocks were then more or less intensely affected in accordance with the different Ar retentivities of different minerals, or different closure temperatures in the case of Rb-Sr isotope systematics. A major problem is seen in the different intensities of the resetting events at different localities within the dome. This may be explained partly by additional hydrothermal activity.

Future investigations are still needed to completely clarify the nature and the duration of post-2-Ga processes that took place in the Vredefort structure.

Acknowledgments: We gratefully acknowledge the generous support from Anglo American Prospecting Services that permitted the analysis of Witwatersrand pseudotachylites, and the permission to report the results.

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AL UMCHAIMIN DEPRESSION, WESTERN IRAQ: AN IMPACT STRUCTURE? James R. Underwood Jr., Department of Geology, Kansas State University, Manhattan KS 66506-3201, USA.

AL UMCHAIMIN, in Arabic "hiding place" or "place of ambush" [1], is located at latitude 32° 35.5'N and longitude 39° 25'E. It lies some 43 km S36° of the H-3 pump station on the abandoned Kirkuk-Haifa oil pipeline [2] and 60 km S49°W of the western desert town of Rutba. The nearly circular depression averages 2.75 km in diameter and is 33–42 m deep. It is floored with fine-grained, clay-rich deposits, estimated to be 36 m thick [3], the surface of which shows well-developed desiccation fissures or mudcracks when dry. Because of its nearly circular planimetric shape and its apparent isolation from other surface and subsurface features, it has been considered by some to be a possible meteorite impact structure [4] and by others [5] to be a surface collapse feature that originated following removal of magma from the subsurface as the magma extruded elsewhere. Al Umchaimin was listed in the U.S. Geological Survey tabulation of 110 structures worldwide for which a meteorite impact origin had been suggested [6]. It was placed in Category VI Structures for which more data are required for classification.

K. M. Al Naqib, Iraq Petroleum Company, reported [7] that the petroleum geology community considered that Al Umchaimin had originated by fracture-controlled dissolution in the subsurface and eventual collapse into the resulting solution cavity. Al-Din and others [3] made geological and geophysical surveys of the depression in 1969 and 1970 and found no evidence for an impact origin. They concluded, as did Al Naqib, that a solution-collapse origin was likely.

Abbas and others [8] conducted additional geophysical studies and arrived at similar conclusions: (1) Al Umchaimin was not formed by meteorite impact and (2) probably it represents a solution-collapse feature. Greeley and others [9], in preparation for the Magellan mission to Venus, studied shuttle radar images of nine maar volcanos, one volcanic caldera dome, one impact structure, and one possible impact structure (Al Umchaimin). Concerning Al Umchaimin, they wrote: "Although no definitive impact features have been reported, the circularity and slightly uplifted rims suggest an impact origin."

In 1965, the author and the late Randolph Chapman, both visiting professors at the College of Science, University of Baghdad, spent half a day at Al Umchaimin during which a section was measured up the east wall, samples were collected for later thin sectioning, and a search made for meteoritic debris, shatter cones, impact glass, melt breccia, and so on. No evidence was found for an impact origin of the depression, nor did study of the thin sections from the east wall of the depression reveal any microscopic evidence of impact.

It is concluded that, on the basis of the studies that have been made of Al Umchaimin and on the basis of the brief site visit made, Al Umchaimin probably is not an impact structure but most likely resulted from the enlargement and coalescence of sink holes and eventual collapse of the roof material into the resulting cavity.

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A LATE DEVONIAN IMPACT EVENT AND ITS ASSOCIATION WITH A POSSIBLE EXTINCTION EVENT ON EASTERN GONDWANA. K. Wang¹ and H. H. J. Geldsetzer², ¹Department of Geology, University of Alberta, Edmonton, Alberta T6G 2E3, Canada, ²Geological Survey of Canada, 3303-33rd Street, N.W., Calgary, Alberta T2L 2A7, Canada.

AN 177157/GU 969733

Evidence from South China and Western Australia for a 365-Ma impact event in the Lower *crepida* conodont zone of the Famennian stage of the Late Devonian (about 1.5 Ma after the Frasnian/Famennian extinction event) includes microtektitelike glassy microspherules [1], geochemical anomalies (including a weak Ir), a probable impact crater (>70 km) at Taihu in South China [2], and an Ir anomaly in Western Australia [3]. A brachiopod faunal turnover in South China, and the "strangelove ocean"-like $\delta^{13}\text{C}$ excursions in both Chinese and Australian sections indicate that at least a regional-scale extinction might have occurred at the time of the impact. A paleoreconstruction shows that South China was very close to and facing Western Australia in the Late Devonian [4].

South China: An Upper Devonian carbonate section exposed at Qidong, Hunan, was studied for biostratigraphy, geochemistry, and sedimentology. A brachiopod faunal changeover from the traditional *Yunnanellina* to *Yunnanella* faunas [5] was recognized in the section. Abundant microspherules were found in a single stratigraphic horizon immediately below a 3-cm clay with a geochemical anomaly. The microspherule horizon occurs in the Lower

crepida conodont zone, based upon the presence of conodont species *Pa. quadrantinosalobata*, *Po. nodocostatus*, *I. iowaensis*, *I. cornutus*, *I. alternatus*, and *Pel. inclinatus* [6], and *Pa. crepida*, *Pa. minuta minuta*, *Pa. quadrantinosalobata*, *I. iowaensis*, *I. alternatus helmsi*, and *I. alternatus alternatus* [7]. Petrographic, SEM, XRD, and electron microprobe analyses indicate that the microspherules were like microtektites produced by a bolide impact, on the basis of their "splash form" shapes, inner bubble vesicles, glassy nature, silica glass inclusions (lechatelierite), and chemical compositions that are similar to those of microtektites. The geochemical anomaly in the 3-cm clay is characterized by siderophiles (Ir, Fe, Co, Cr) and chalcophiles (Se, Sb, As) enriched by factors of 1 to several orders of magnitude over their background values, although Ir abundance in the clay is low (38 ppt). The $\delta^{13}\text{C}$ maintains constantly positive values in the carbonate samples below the clay, but shifts suddenly to a minimum of -1.97‰ in the clay and above. Although the carbonate rocks we analyzed were altered to some degree by diagenesis (as seen in the thin sections), we believe that the trend of the carbon isotopic change is still preserved. A "strangelove ocean"-like $\delta^{13}\text{C}$ excursion of 2.7‰ (PDB) in the Qidong Section is consistent with the paleontological data suggesting that an extinction might have terminated the *Yunnanellina* fauna, which in turn gave rise to the *Yunnanella* fauna. Taihu Lake, a large circular structure, has long been speculated to be a probable impact crater. Recent work, on the basis of shock metamorphism found in the target sediments, has suggested that it is a probable impact crater [2].

Western Australia: A strong iridium anomaly (20 times the background value) was initially reported in the Famennian Upper *triangularis* conodont zone in the Canning Basin, Western Australia [3]. An evaluation of the conodont fauna proved that the Ir anomaly is actually in the Lower *crepida* zone, based upon the occurrence of *Pa. crepida* [8]. This strongly indicates that the Canning Basin Ir anomaly occurs at the same stratigraphic level as the Qidong microspherule and geochemical anomaly horizon. Because the Australian Ir anomaly is associated with a *Fruetexites* stromatolite, the interpretation was that the Ir was concentrated biologically by the cyanobacteria. We acknowledge this scenario but further propose that there must have been abundant Ir available in the environment for the biological concentration to take place. The most probable source for Ir is an impact near the region, such as the impact in South China. The presence of *Fruetexites* stromatolites is probably the reason why there is a stronger Ir anomaly in the Canning Basin than in the Qidong area, where no *Fruetexites* stromatolites are present. A negative $\delta^{13}\text{C}$ excursion of about 1.5‰ is coincident with the Ir anomaly in the Canning Basin, and has been suggested to indicate a decrease in biomass [3].

The carbon isotopic excursions, which occur at the same stratigraphic level in both South China and Western Australia cannot be explained as being coincidental. The $\delta^{13}\text{C}$ excursions and the brachiopod faunal turnover in South China indicate that there might have been at least a regional (possibly global) extinction in the Lower *crepida* zone. The impact-derived microspherules and geochemical anomalies (especially the Ir) indicate a Lower *crepida* zone impact event on eastern Gondwana. The location, type of target rocks, and possibly age of the Taihu Lake crater qualify as the probable site of this Late Devonian impact.

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580-46 N93-10P192 475244
ELECTRON PETROGRAPHY OF SILICA POLYMORPHS ASSOCIATED WITH PSEUDOTACHYLITE, VREDEFORT STRUCTURE, SOUTH AFRICA. J. C. White, Center for Deformation Studies in the Earth Sciences, Department of Geology, University of New Brunswick, Fredericton, New Brunswick, Canada E3B 5A3.

High-pressure silica polymorphs (coesite and stishovite) have been described from the Vredefort structure [1,2] in association with pseudotachylite veinlets. In addition to the fundamental significance of the polymorphs to genetic interpretations of the structure, it has been additionally argued that the type of pseudotachylite with which they occur forms during the compressional phase of the shock process, while the larger, classic pseudotachylite occurrences are barren of polymorphs and formed during passage of the rarefaction wave. This identification of temporal relationships among transient shock features at a regional scale is similar to observations from the Manicouagan structure, Quebec [3], where texturally distinct diaplectic plagioclase glasses formed during both compressional and decompressional phases of the shock process. The clarification of such relationships impinges directly on interpretations of natural shock processes and the identification of high probability targets for polymorph searches.

Detailed analytical scanning (SEM) and transmission electron microscopy (TEM) has been utilized to further establish the nature of both the pseudotachylite and the silica polymorph occurrences in

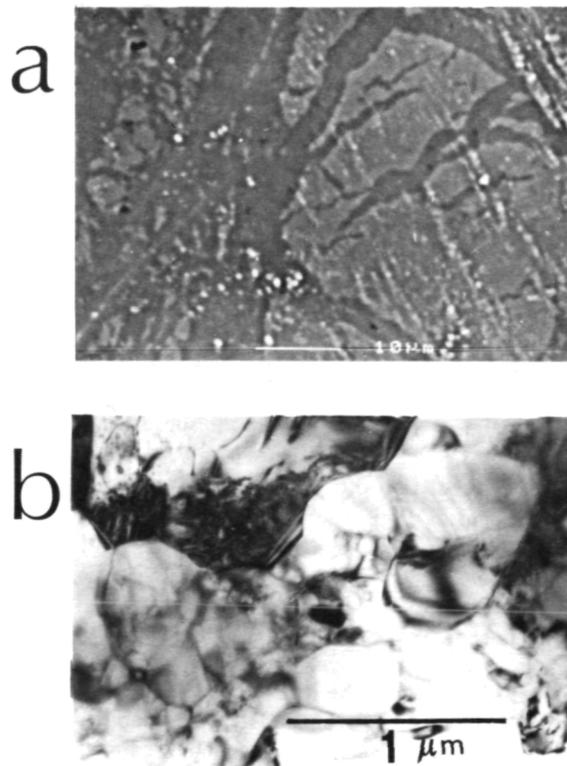


Fig. 1.