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Polymetallic and Nitrogen Carbide Debris in Ferruginous Palaeosol from the Libyan Desert Glass Area, SW Egypt: Further Evidence of a Cometary Origin for the Diamond-bearing Hypatia Stone

Andreoli, M.A.G.[1], Belyanin, G.[2], Block, D.[3], de Kock, D.[4], Di Martino, M.[5], Gibson, R.L.[1], Huotari, S.[6], Jinnah, Z.[1], Kramers, J.[2], Mouri, H.[2], Ntsoane, T.[3], Pischedda, V.[7], Serra, R.[8], Sigalas, I.[9], Stengel, I.[10], van der Merwe[3], R., Ziegler, A.[11], Zinner, E.[12]

[1] School of Geosciences, Witwatersrand University, Johannesburg, South Africa, Marco.Andreoli@wits.ac.za
[2] Dept. of Geology, University of Johannesburg, Johannesburg, South Africa
[3] South African Nuclear Energy Corporations, Pretoria, South Africa
[4] Deaprtment of Applied Mathematics, Witwatersrand University, Johannesburg, South Africa
[5] INAF – Osservatorio Astrofisico di Torino, Pino Torinese, Italy
[6] University of Helsinki, Helsinki, Finland
[7] ILM, Université de Lyon 1, Villeurbanne, France
[8] Dipartimento di Fisica e Astronomia, Universita' di Bologna, Italy
[9] Polytechnic of Namibia, Windhoek, Namibia
[10] Department of Metallurgy, Witwatersrand University, Johannesburg, South Africa
[11] Microscopy and Microanalysis Unit, Witwatersrand University, Johannesburg, South Africa
[12] Deceased

Following the discovery of a diamond-bearing carbonaceous pebble in the Libyan Desert Glass (LDG) area of SW Egypt [1], subsequent investigations accounted for the extraterrestrial origin of this stone, nicknamed Hypatia, either as a shocked comet relic [1, 2] or an unusual meteorite [3]. Our expedition to the find area failed to recover similar material, but returned samples of goethite-cemented, Cenozoic pebbly sandstone with pedogenic characteristics widely represented in the region. One of these samples, less than 1 kg in weight, was crushed and digested in acids (*aqua regia* ± HF) followed by bromoform separation to test for nanodiamonds in the heavy minerals fraction. This investigation is on-going and involves several micro-analytical techniques, including synchrotron tomography and Raman spectroscopy. In addition to aluminosilicates, pyrite, ilmenite, zircon and rutile, a large number of unusual metallic and carbonaceous particles have been recovered. These may be divided into three main groups: I) mainly spherical to ovoid metallic particles either single or clustered (size range: ~1 mm to < 1 μm); II) flakes of partly oxidized Al>Si (±Bi, Fe) metal (size: ~50 x ~80 μm); and III) carbonaceous mineraloids, including the first occurrence of a natural carbon nitride. With regard to (I) new work on two mm-sized Ti-metal clusters shows that they are alloyed to ~1.0 atomic % Al and locally host quenched gas bubbles, blebs of titanium aluminide, N-α-Ti, aluminum oxycarbonitride, and monometallic particles of Zr, Ag, and Zn. In places, the Ti-metal clusters are also coated by films and filaments of graphitized carbonaceous matter. Metal spherules of Ag and/or Ti (in varying proportions with Si, Al, Ca, O and minor Na, Mg, S), and grains of SnPb and Si>Al, Ti, Ca are common in the finer, <30 μm, size fraction of the sample. In order to explain the groups above, we considered various models: anthropogenic or geological products, fulgurites, cosmic spherules, metal-rich meteorites, or impact-related melts and carbonaceous matter. No example was found in the literature to support any of these interpretations; however, grains of metallic silver, aluminium and titanium occur in the Hypatia stone [4,

5]. In conclusion, our finds suggest that the LDG area may be underlain by a strewn field derived from a comet with an unusual chemistry and constituents never seen before in nature.

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