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A photo of the Tissint Martian meteorite showing a hand sample that weighs 327g. Dark patches and veins on the broken surface are melt formed by a shock event that took place on Mars. Dark fusion crust can be seen on the left side. Photo: Hui Ren, Institute of Geology and Geophysics of the Chinese Academy of Sciences in Beijing.

Did life on Mars exist?

New insights into organic carbon in the Tissint meteorite

It was July 2011 when the Martian meteorite Tissint fell to Earth. An international research team has found organic carbon in rock sections of the meteorite and precisely unraveled its petrographic settings. The new results are presented in the periodical “Meteoritic and Planetary Science (MAPS)”. There is persuasive evidence that the carbon originated on Mars. The scientists are convinced that biotic processes can explain all of their results better than abiotic processes. At the same time, however, they do not entirely rule out the possibility that the carbon could have originated from abiotic processes.

Prof. Dr. Ahmed El Goresy,
Bayerisches Geoinstitut (BGI), University of Bayreuth.

A highly renowned scientist

From the University of Bayreuth, Prof. Dr. Ahmed El Goresy was part of the international team and contributed significantly to the new findings. Since 2005 he has been a guest professor at the Bayerisches Geoinstitut (BGI), an international research centre of Bayreuth University. The Meteoritical Society, the leading international association for research of meteorites and planets, awarded him 2013 its Leonard medal – the highest award in the field of meteoritical studies.

Organic carbon originating from Mars

It was already known to the research community that the Tissint meteorite, as well as another 12 Martian meteorites that had previously been collected on Earth, contains organic carbon. However, it has always been a matter of debate whether this carbon formed after the meteorite's fall on Earth. The authors of the new publication in MAPS refer to the short time between the fall and the finding of Tissint, when they argue that the carbon detected and analysed in their investigation did not originate on Earth, but during a much earlier phase on Mars, i.e., several hundred million years ago.

They make their case in particular by three compelling reasons: (1) Organic carbon is located in microscopic veins of Tissint that must have been produced by a sudden melting process. It is implausible that such a process could occur in the desert area of Morocco where the meteorite fell. (2) Some carbon grains exist within the veins in Tissint in the form of diamond. No conditions are known in which diamond could have formed on the surface of this North African region. (3) The organic carbon in Tissint contains a very high proportion of deuterium, a heavy hydrogen isotope carrying one proton and one neutron in its nucleus. “Such an enormous concentration of deuterium is the typical ‘finger print’ of Martian rocks as we know already from previous measurements”, says El Goresy.

Biotic origin in good agreement with the results obtained

Is the organic carbon within Tissint of biotic origin? Did microorganisms exist in that early phase of Mars that contributed to its formation? The authors point out that this would be in good agreement with the research results obtained. Another indication supporting their interpretation emerges from analyses by nano-scale secondary ion mass spectroscopy (NanoSIMS) which revealed a significant depletion of the carbon isotope ^{13}C. The carbon isotope signature shows certain similarities to those observed in biotic activities on Earth.

„We cannot and do not want to entirely exclude the possibility that organic carbon within Tissint may be of abiotic origin” states Prof. Dr. Yangting Lin, the senior author of the publication in MAPS. He is professor at the Institute of Geology and Geophysics of the Chinese Academy of Sciences in Beijing and explains: “It could be possible that the organic carbon originated from impacts of carbonaceous chondrite meteorites. However, it is not easy to conceive by which processes chondritic carbon could have been selectively extracted from the impacting carbonaceous chondrites, selectively removed from the soil and later impregnated in the extremely fine rock veins”. Some scientists have argued that the carbon of Tissint was synthesized in a hot magma that intruded into rock fissures. But this possibility could be refuted by the international research group.

Support from the Bayerisches Geoinstitut at the University of Bayreuth

“We appreciate very much and we are quite proud that Prof. Ahmed el Goresy, a long term guest professor at the Bayerisches Geoinstitut (BGI), could contribute substantially to the re-

sults being published now", acclaimed Prof. Dr. Tomo Katsura, the director of the institute. He continues: "At BGI we intend to support his research on meteorites also in the future – both by optimal sample preparation facilities as well as with research technologies that will be applied in investigations of this material, in order to contribute to better understanding about the origin of the organic carbon in Martian meteorites." "Our excellent preparation laboratory at BGI guarantees that the samples are not contaminated before they are investigated", adds El Goresy.

Meteorite research: analyses of undestroyed matter

The authors do not see any rivalry between investigations of Mars meteorites and rocks from the surface of Mars that are carried out by the US space agency NASA in the framework of the Mars Science Laboratory (MSL). "Mars rovers like 'Curiosity' represent a fantastic progress in technology. They do a very good job addressing the question if there are or were suitable conditions on Mars to support life" says El Goresy. "In one sense, however, meteorite research has always been superior so far: Mars rovers collect, pulverize and analyze bulk samples and therefore obtain only average composition data. In contrast microscopic and in situ spectroscopic investigations enable analyses of undestroyed individual carbon grains exactly in the place where they occur", he explains.

Information on Professor Ahmed El Goresy (in German):

www.uni-bayreuth.de/presse/Aktuelle-Infos/2012/277-Leonard-Medaille-2013.pdf

Publication:

Yangting Lin et al.,
NanoSIMS analysis of organic carbon from the Tissint Martian meteorite: Evidence for the past existence of subsurface organic-bearing fluids on Mars,
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Photos:

S.1: Hui Ren, Institute of Geology and Geophysics of the Chinese Academy of Sciences in Beijing; free for publication when references are included.

S.2: Chr. Wissler, Universität Bayreuth; free for publication.

In high resolution for download: www.uni-bayreuth.de/presse/images/2014/231