Oldest natural carbon micro-and nanotubes on the Earth

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Synthesising and isolating new forms of carbon allotropes (fullerenes, nanotubes, graphene) has been the focus of much scientific and industrial research during the last three decades in different countries. In magmatic and metamorphic rocks the main form of carbon allotropes is graphite that usually observed in the form of lamellar crystals of hexagonal syngony.

However, the study of graphite mineralization in intrusive rocks have established submicroscopic carbon of different morphologies in the forms of singlewalled and multiwalled micro- and nanotubes, foam-like and wool-like spongy aggregates, onion-like carbon particles and graphene. The combination of all of these forms in a single aggregate is an intriguing challenge to the existing models of the formation of carbon nanostructured materials.

Study of multiple scan-frames allowed to distinguish different morphological forms of carbon nanostructured materials: 1) Cylindrical tubes consisted of three complex zones: a) the inner hollow tubes (diameter less than 100 microns (μm)); b) intermediate foam-like layer (10-20 μm); c) outer zone consisting of a "forest" of microtubes (diameter - 1-5 μm) and nanotubes (diameter 100nm). 2) Planar carbon structures, characterized by zonal morphologies: a) plane of nanometer thickness; b) intermediate foam and wool-like layer (20 μm); c) microtubes and nanotubes emerged from the intermediate layer (diameter less than 5 μm, length - 100-150 μm). 3) Large onion-like fullerens (diameter ~5 μm).

Carbon isotope composition analyses of different carbon morphologies have shown the variability of the $\delta^{13}C$ values in range from -12.5 to -14.6‰ (VPDB).

The available data on the morphology of nanostructured materials and their combination in single aggregate, as well as isotopic data allow to reconstruct the processes of formation of carbon nanomaterials in the natural environment that is of interest for specialists in nanotechnology.

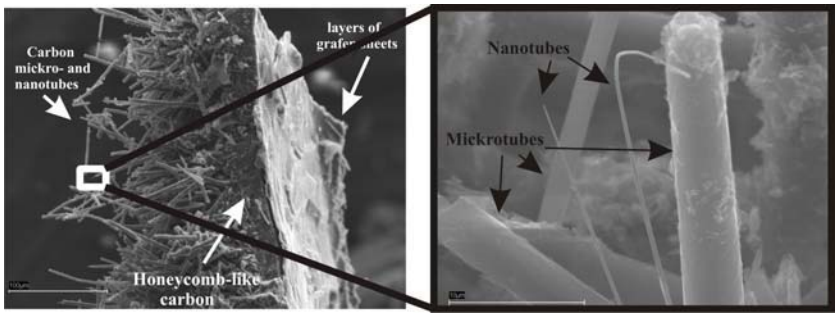

Figure. The fragment of the carbon aggregate (the scale: figure - 100 μκ, inset – 10 μκ).