Nature of Precambrian Graphites

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The carbon (graphite) of Precambrian gneisses of the Azov region of the Ukrainian shield was investigated. Average content in quartzites was found to be 0.45%, that of pyroxene-plagioclase gneisses 1.26%, and that of marble 0.56%. The carbon content was compared with the ratio of petrogenic elements in the rocks. See Fig. 1. Most of the carbon turns out to be concentrated in the leucocratic gneisses. The latter correspond with sedimentary analogs - carbon-bearing sandy-clayey sediments. The graphite in the amphibolites, marbles, and quartzites appears to be the product of metamorphism of more mobile organic compounds - oil hydrocarbon gases. This idea is based on the fact that the source analogs of amphibolite, marble, and quartzite (basic volcanics, carbonates, and sandstones) do not characteristically contain large amounts of syngenetic organic matter.

The isotopic composition confirms the biogenic nature of the Precambrian graphite. Fig. 2 is a composite histogram of distribution of carbon isotopes. Values of δC-13 group as follows: -0.6 to -1.5, -1.5 to -2.5, -2.5 to -3.5%, and others. To the first group belong the graphites from the carbonates and shales. To the second and third groups belong part of the quartzites, amphibolites, amphibole and granite gneisses, plagiogneisses, and other graphite-bearing metamorphic rocks. The fourth and subsequent groups consist of the rest of the quartzites, amphibolites, melanocratic gneisses, kyanite schists, phyllites, shungites, and other rocks.

The wide range in isotopic composition of the carbon of the graphites in the Precambrian sediments can be explained by different sources of the organic matter. Comparison of the isotopic composition of the carbon of these groups of Precambrian rocks with Phanerozoic and modern carbon shows that the first group with a δC-13 value of about -1.4 corresponds with marine organic matter; the second with a value of about -2.5 corresponds with land material and coal; the third with a value of about -3.0 corresponds with gas condensate and oil; and the subsequent ones with values of -4.0 and lower correspond with hydrocarbon gases. These relationships suggest that during the Precambrian, biogenic matter accumulated and derivative products (oil, etc) formed; subsequent metamorphism converted these to graphite.

A similar distribution of hydrocarbons is observed on the African platform. Fig. 2 shows maximums that correspond to the bio-mass for sea and land (I and II), coal (II), and gas condensate, oil-gas, and gas pools (III-IV). There is an unexplained shift of all maximums by 0.1 to 0.2 to the right. The direction of variation in time of the isotopic composition of the carbon of graphites and the content of organic carbon in the rocks beginning with the earliest dated samples (3.5 m. y.) is not marked. It is possible at this time the entire reserve of carbon of the planet available to living organisms had already become involved in the biochemical cycle.