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COMMENT

Comment on "Mantle hydrocarbons: Abiotic or biotic?" by R. Sugisaki and K. Mimura

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I should like to offer the following comments upon the excellent article by Sugisaki and Mimura (1994).

The article by Sugisaki and Mimura confirms and reproduces the earlier results by Mogarovskiy et al. (1980) in Russia. Mogarovskiy and his coworkers established that bitumens with the characteristics of crude petroleum are found in ranges of 6–80 ppm in magmatic and metamorphic rocks, and that the concentration of dispersed hydrocarbon material is greatest in the rocks that are clearly of mantle origin (xenoliths of garnet pyroxenites) and slightly lesser in the mantle derived rocks (kimberlite pipes and alkali basaltoid rocks, e.g., fergusite-porphyries and tinguaites). The concentrations diminish further in granulites and related basic rocks (xenoliths of eclogites and basic granulites, amphibolites, ultrabasic rocks, eclogite-like rocks, and charnockites) and are observed to be least in the granite-gneiss type rocks (gneisses, quartzites, marbles, and granites). Mogorovskiy et al. (1980) concluded that the crude petroleum they observed was of abiotic origin.

The conclusions of the article by Sugisaki and Mimura (1994) confirm and bear out also the earlier analyses by Marakushev and Perchuk (1974) and by Letnikov (1977). The observations by Sugisaki and Mimura (1994) are also consistent with the monumental analysis of Chekaliuk (1971) as well as with his later work (Chekaliuk and Kenney, 1991).

There is one point in the article by Sugisaki and Mimura (1994) for which their own words do not do full justice to their results: In their first paragraph of the section titled, "Recycled Biogenic Hydrocarbons" on p. 2539, they wrote: "Two candidates as the source of the mantle hydrocarbons described above, synthesized hydrocarbons and preserved ones in the mantle, are accompanied by the perplexing problem of pristane and phytane."

Many scientists in both the Russian Academy of Sciences and in the Academy of Sciences of the Ukraine consider the presence of those molecules not at all to be a "perplexing problem." The observation by Sugisaki and Mimura (1994) of these molecules in mantle-derived rocks demonstrates the same property for pristane and phytane as did earlier observations by Nagy, Ponnamperuma, and others who worked on the occurrence of porphyrin molecules in the interiors of carbonaceous meteorites: namely, that such molecules are not necessarily of biogenic origin. The observations by Nagy (1975) and others refuted the previously held notion that such molecules are necessarily of biological origin. The same conclusion holds for the observations of pristane and phytane in mantle derived rock by Sugisaki and Mimura (1994).

Furthermore, it deserves note that a number of workers including Gelpi and Oro (1969, 1970) and Vdovykin (1974) have previously identified both pristane and phytane in the interiors of meteorites. Specifically, Gelpi and Oro (1969, 1970) identified isoprenoids including pristane and phytane among the carbonaceous matter of the Groznaya meteorite.

The results by Sugisaki and Mimura (1994) are even more significant for these reasons.

A fine point which might be modified is the conclusion by Sugisaki and Mimura (1994) that hydrocarbons of mantle origin (i.e., hydrocarbons from the mantle) have a carbon isotope signature of approximately −27‰ on the PDB scale. I offer an alternate explanation to the conclusion by Sugisaki and Mimura (1994) that hydrocarbons in the mantle may be characterized by such a carbon isotope ratio.

The hydrocarbons which Sugisaki and Mimura (1994) observed in mantle xenoliths were delivered to the crustal environment in the interiors of these rocks, and in such circumstances these hydrocarbons were isolated from the physical processes and chemical reactions which are unavoidable throughout the course of a normal fluid transport process. In the latter case, the hydrocarbons would surely have become progressively lighter by the process of Rayleigh fractionation as they proceeded along their transport path from the mantle into the crust. Such a result is exactly what Colombo et al. (1967, 1968) demonstrated in their classic experiment on the subject. It deserves note also that Galimov (1967) established that, once in the near-surface crustal environment and subject to biological fractionation, an assemblage of hydrocarbon molecules can be expected to undergo metabolic fractionation which will cause the carbon to become isotopically heavier. Both of these processes are too often overlooked in the literature on carbon isotopes.

The main features of several of the hydrocarbon chromatographs in the article by Sugisaki and Mimura (1994), especially those from the samples taken, respectively, from the Muroto shale and the Iwanai tectonite, are almost identical to those of the oil pumped out of well Gravberg 1 drilled to a depth of more than 6,000 meters into Precambrian granite in the Siljan Ring in Sweden (Kenney, 1994). All are peaked around the approximate carbon weight C_{14}. Particularly to be noted is the similarity of the shape of these curves to a discrete Planck distribution curve. This is exactly as expected. The time and temperature of formation can be calculated from the details of such curves as demonstrated by Chekaliuk (1971).

The technique used by Sugisaki and Mimura (1994) of gas chromatography of both washed and unwashed specimens taken from the same sample to establish that the hydrocarbons present in the rock samples originated from the rock matrix and not from surface contamination, is exactly the same as that used by this writer to analyze the hydrocarbon fluids in rock cuttings during the drilling of the well Stenberg 1 of the Swedish deep gas exploration project. The results observed from the hydrocarbon gases in the rock cuttings from Stenberg 1 were very similar to those reported by Sugisaki and Mimura (1994), as were our conclusions of an abiotic origin of the hydrocarbons.

Furthermore, the observations reported by Sugisaki and Mimura (1994) and their conclusions for an abiotic origin of these hydrocarbons are strongly supported by similar recent analysis of solid hydrocarbon material in mantle derived basalt from Syria by Mahfoud (1991).

In summary, the observations reported by Sugisaki and Mimura (1994) and their conclusions of an abiotic origin for these hydrocarbons are not only consistent with the earlier cited geological observations reported by scientists in Russia and the C.I.S., but also confirm the most recent theoretical statistical thermodynamic calculations for the stability of the C–H system at temperatures and pressures characterized by the lower crust and upper mantle of the Earth (Kenney, 1993).

Furthermore and of direct importance, it deserves note that the conclusions stated by Sugisaki and Mimura (1994) are not at all simply matters of academic interest. In Russia and the C.I.S., such scientific reasoning has been actively applied with much success to petroleum exploration and production. Several substantial results of the application of such reasoning have been reported independently by Krayushkin et al. (1994).

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