An experimental study on Fischer-Tropsch catalysis: Implications for planetary science

Y. SEKINE[1], T. SHIDO[2], S. SUGITA[1], T. MATSUI[3], T. YAMAMOTO[2]AND Y. IWASAWA[2]

[1]Dept. of Earth and Planetary Science, Univ. of Tokyo
[2]Dept. of Chemistry, Univ. of Tokyo
[3]Dept. of Complexity Science and Engineering, Univ. of Tokyo

The Fischer-Tropsch catalysis, in which CO and H_2 are converted to hydrocarbons on the surface of iron and nickel catalysts, has been suggested to play a key role in organic synthesis in impact phenomena and solar nebula chemistry (1,2,3). In this study, we conducted Fischer-Tropsch catalytic experiments at low pressures (1.0×10^{-4} bar $\leq P \leq 0.3$ bar) and various range of H_2/CO ratios (0.25 to 1000). Such conditions are very important in planetary science. However, the reaction rates under such conditions have not been studied before.

We investigated the methane formation rate of Fischer - Tropsch catalysis over iron and nickel powders using GC and QMS. The results indicate that the methane formation rate over iron catalyst has strong dependency on pressure and that metallic nickel is an much more efficient catalyst at low pressures than iron (Figure 1).

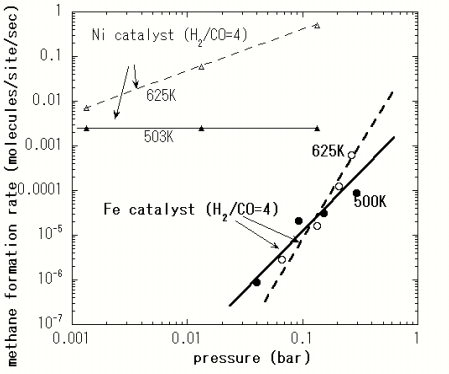

Figure 1: Methane formation rate as a function of pressure.

This result suggests that nickel may have been the main catalyst of Fischer-Tropsch catalysis in impact phenomena and the solar nebula chemistry. Analysis of the experimental result shows that the difference in pressure dependence between iron and nickel comes from three process: the catalytic reaction steps concerning disproportionation rate of CO, hydrogenation rate of surface carbon, and poisoning of the catalysts.

References

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More radiogenic Os in continental-side ultramafic rocks of Japanese Islands

SENDA RYOKO[1] AND TANAKA TSUYOSHI[2]

[1]Dept. Earth and Planetary Sci., Nagoya Univ., Nagoya, 464-8602 Japan (sen@gcl.eps.nagoya-u.ac.jp)
[2]Dept. Earth and Environmental Sci., Nagoya Univ., Nagoya, 464-8602 Japan (tanaka@eps.nagoya-u.ac.jp)

Various types of volcanics, tholeiitic to alkaline, occur in island arcs and their isotopic variations provide information on the arc mechanisms and mantle materials. Some information for mantle materials lain underneath the island arcs is known by volcanics and their lithophile feature. A few mantle peridotite appears as tectonitics and/or in volcanics. The xenoliths are metasomatized in many cases and difficult to examine them using the same trace lithophiles as volcanics. To make clear the lower crust and upper mantle below the Japan arc directly by ultramafic rocks, we examined the Os and Ir abundances and Os isotope ratios of the ultramafic xenoliths in the northern part of Kyusyu, southwest Japan (5 dunite xenoliths and 1 host rock of alkali-basalt). Here is the closest place to Asian continent in Japan.

For Ir abundances, we concentrated the platinum group elements to Ni-S beads by Ni-S fire assay from sample powder with spike solution (^{191}Ir) and flux, dissolved the beads in conc. HCl to remove Ni-S, then measured the isotope ratios with a Q-TIMS. The determination of Os abundances and Os isotopic ratios are as followed. Sample powder was digested in Carius-Tube with ^{190}Os spike solution. And then, we extracted Os with solvent extraction and purified by micro distillation method. The measurements of Os isotope ratios were by N-TIMS.

One result of Ir concentration is 4.69±0.74ppb which averaged the 5 times analysis and another is 2.43±1.04ppb averaged 9 times analysis. These values are similar with the Horoman ultramafic complex (3.6-4.3ppb), Hokkaido, Japan. The Os isotope ratios are around ^{187}Os/^{188}Os=0.1443. It is higher than those of other ultramafic xenoliths and complexes in Japan; ^{187}Os/^{188}Os=0.1181-0.1334 from Horoman ultramafic complex (Liu and Tanaka, 1999) and ^{187}Os/^{188}Os=0.1206-0.1338 from peridotite xenoliths of Ichinomegata, northeast Japan (Brandon et al., 1996). The Kyusyu ultramafic xenoliths have more radiogenic ^{187}Os than those of the Horoman ultramafic complexes and the Ichinomegata peridotite xenoliths. Kyusyu is situated nearer to Asian continent than the other two regions. These data could be showed their origins are vary from Pacific side to Comtinental side below the island arc.

References

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