

## Effects of olivine as a catalyst for the formation of organic compounds in meteorites

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### INTRODUCTION

Many classes of organic compounds have been identified in carbonaceous meteorites, which imply a complex history of chemical evolution in extraterrestrial environments. In the previous study (Yamashita and Naraoka, 2014), saturated- and unsaturated-alkylpyridines were reported with extensive homologous series ranging from C<sub>1</sub> to C<sub>20</sub> in the Murchison meteorite, which could be produced through aldol condensation of aldehydes in the presence of ammonia. The pyridine-derived compounds such as pyridine carboxylic acids (including nicotic acid) and alkylpiperidines were also found in Murchison, probably resulting from the alkylpyridines by oxidation and reduction, respectively, on the meteorite parent body.

### EXPERIMENTAL

The simulation experiments were performed in this study to pursue reaction mechanisms for the occurrence of alkylpyridines and their derivative compounds in meteorites. Aqueous solution containing aldehydes (HCHO and/or CH<sub>3</sub>CHO) and ammonia were heated in the presence or absence of olivine powder as a catalyst in a glass ampoule after N<sub>2</sub>-purging at 50-100 °C for 5-26 days. The reaction products were analyzed by high performance liquid chromatography/mass spectrometry with electrospray ionization.

### RESULTS AND DISCUSSION

Alkylpyridines were commonly observed in the reaction products. However, the alkylpyridine distribution was different depending in the presence or absence of olivine. Longer alkylated (up to C<sub>20</sub>) pyridines were produced with olivine, while only shorter alkylated (up to C<sub>7</sub>) ones were produced without olivine. The olivine surface can provide reaction sites to support elongation of alkylpyridines during aldol condensation. In addition, pyridine carboxylic acids were present with olivine, but absent without olivine. The chemical oxidation of alkylpyridines could be promoted by olivine. Thus, the effects of olivine are remarkable as catalysis to control the compound distribution observed in carbonaceous chondrites.

### REFERENCE

Yamashita, Y. and Naraoka, H. (2014) Two homologous series of alkylpyridines in the Murchison meteorite. *Geochem. J.* **48**, 519-525.

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