Identification of K-rich fragments in chondritic breccias using Imaging Plate (IP): an application to the planetary materials.

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Introduction:

Some of the LL-chondritic breccias, Bhola, Kraehenberg, Y-74442 and some others, contain alkali-rich fragments [1-4], therefore they could be quite useful samples to investigate the alkali differentiation processes occurred possibly on their LL-parent bodies during the early stage of the solar planetary system. In terms of cosmochronological interest, more precise dating might be possible utilizing the parent-daughter pairs of long-lived (^{40}K-^{40}Ar, ^{40}K-^{40}Ca and ^{87}Rb-^{87}Sr) and short-lived (^{135}Cs-^{135}Ba) radionuclides in alkali-rich chondritic breccias. For such purpose, however, nondestructive test and separation of tiny alkali-rich fragments or portions in the chondritic breccias prior to chemical and isotopic analyses is preferred because the alkali enrichment is often limitted within very small spots, say less than 1 mm across. In order to discriminate and separate alkali-rich fragments from others, we conducted radiography experiments on small fragments of the LL-chondritic breccias using Imaging Plate (IP) which is very sensitive to radioactivity so that we can reveal potassium distribution on surface of various materials and tissues detecting radioactivity of ^{40}K.

Samples and experiments:

A part of chunks from Y-74442,87 (~1.5g) were gently crushed into grains of around 1mm across in an agate mortar. More than one hundred of grains of 0.4 to 3.2 mg, dark or light in color, were collected by hand-picking. Each of the grains was put into a small cellulose capsule, then the capsule set in a hole on sample holder (Al-Cu alloy or acryl plate with many holes or sleeves). The bottom end of each hole/sleeve is slightly narrower so that the capsules can be hold within the holder plate when being transported and that the sample grains are placed close to IP with a thin capsule wall between them when they are set together in a shielding box for IP radiography. The radiography experiments were done using an IP (Fujifilm BAS-MS2040, 20 x 40 cm) and a lead-armored shielding box in a storeroom of Fujifilm Corp. head office building. The exposed IP was read by resolution of 100 x 100 μm using Fujifilm BAS-2500. Additional and more detailed IP exposure experiments for several kinds of standard materials were done at Radioisotope Research Center, The Jikei University School of Medicine.

The Rb and Sr contents of Y-74442 grains used for IP radiography were measured by isotope dilution mass spectrometry at Okayama University.

Table 1. Rb and Sr contents and IP indication to ^{40}K (IP*) for a 166 days-exposure. IP*: roughly classificated by eye measurement

Sample ID	Weight (mg)	IP*	Rb (ppm)	Sr (ppm)
#121	2.919	+	47.7	11.1
#122	1.018	+++	347.4	318.2
#123	1.350	++	161.6	21.3
#124	2.265	-	1.8	7.4
#125	2.163	-	6.6	36.0

Results and discussions:

Exposure time of one week for the first experiment on Y-74442 fragments was not enough to identify any K-rich fragments. Second one was 166 days-long, and this time we found dark spots on the IP for 16 of 130 grains (~12%) suggesting that they should be relatively K-rich. Background level was unexpectedly high. This must be due to the sample holder made of Al-Cu alloy which could be contaminated with some radioisotopes during the course of metal recycling. Thus detection limit probably improves significantly if using a sample holder made of plastic instead of such common metals. The Rb content of five grains shown in Table 1 and Fig. 1 (1.8 to 347 ppm) are quite variable and the difference between the average Rb contents of "K-rich" (186 ppm for #121, 122 and 123) and "not K-rich" (4.2 ppm for #124 and 125) is evident. In addition, it is noted that very high Rb contents are found in smaller fragments (Table 1). This indicates that the alkali enrichment is limited within very small areas, probably due to heterogeneous distribution of tiny alkali host mineral(s) such as alkali feldspar.

When determining the precise Rb-Sr isochron age of alkali differentiation processes occurred on LL-bodies, nondestructive and semi-quantitative methods in K analysis are very useful to identify alkali-rich portions among the heterogeneous chondritic breccias. IP is one of the best tools to easily detect K-rich fragments of small amounts (< 1 mg).

References:

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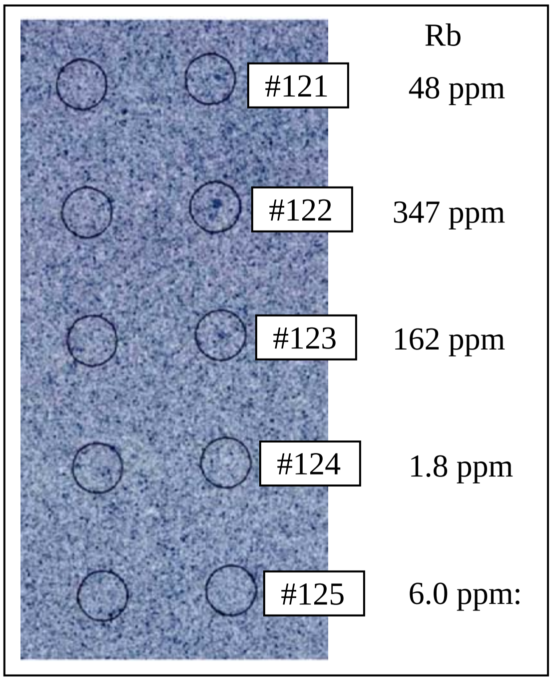

Fig.1 Read image of IP after 166 days-exposure to the grains of Y-74442,87 (LL). The corresponding sample numbers and Rb contents are given on the right.. .