

## Partitioning behavior of Cs in the matrix of simulated ash residues

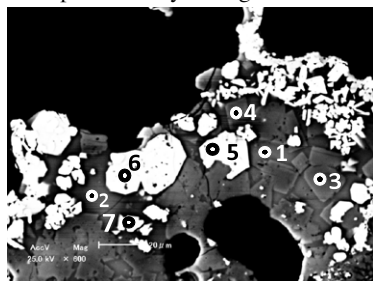
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Tohoku great earthquake and tsunami of March 11, 2011 caused massive explosions at Fukushima I Nuclear Power Plant. Such incidents led to the dissemination of fission products (such as <sup>131</sup>I, <sup>134</sup>Cs, <sup>137</sup>Cs) in a broad geographic area [1, 2]. These radionuclides concentrated in the surrounding natural environments [3] as well as in the debris left from the disaster. Incineration of combustible fraction of disaster debris resulted in the higher level of radioactivity (Cs-related) in the generated ash residues (up to 100,000 Bq/kg in fly ash in some areas), thus banned landfilling.

To model the behavior of radioactive Cs in the ash residues, simulated ash was produced by fusing RDF and Cs salts (non-radioactive) at high temperatures (800-1000 °C). The products mainly consist of glassy matrix (silicate) and a variety of crystalline phases



(Fig 1). Microbeam analysis indicates that Cs is essentially distributed within the glassy matrix of the ash with little or no partitioning within the crystalline phases (Table 1). Binding of Cs in the silicate structure of the glass is a good evidence for the entrapment of analogous radioactive Cs. Additional experiments are underway to examine the chemical form of Cs and to improve

**Fig. 1:** SEM image of the ash matrix

Phases	Glass		Crystalline				
	1	2	3	4	5	6	7
Cs	1.75	1.51	0.00	0.00	0.00	0.00	0.00
Al	6.16	7.12	4.13	3.71	0.90	0.91	1.14
Si	28.73	28.68	24.53	23.99	16.77	16.92	4.07
Ca	5.30	4.38	20.94	19.38	23.72	23.47	2.01
Fe	15.65	10.70	8.22	9.03	20.96	20.42	60.93
K	2.95	2.76	0.24	0.29	0.18	0.17	0.28

the ash quality in order to meet the standards for landfilling.

**Table 1:** Chemical composition of the points in Fig 1 (Wt%).

[1] Kato *et al.* (2012) *J. Env. Radio* **111**, 59-64. [2] Hirose (2012) *J. Env. Radio* **111**, 13-17. [3] Yasunari *et al.* (2011) *PNAS* **108**, 19530-19534.

## The H<sub>2</sub>O-CO<sub>2</sub>-(K, Na)Cl fluids, melting of the tonalite gneiss, and the A-type granitic magmas: Experimental evidence for connection

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The A-type (anorogenic) granites, a specific variety of ferroan granitic rocks forming predominantly during crustal extension, are distinct by their medium-to-high peralkalinity (low Al<sub>2</sub>O<sub>3</sub> and high K<sub>2</sub>O+Na<sub>2</sub>O contents), low CaO, elevated contents of F and Cl. Partial melting of the Archean TTGs in the continental basement is discussed among models to explain origin of these granites. However, neither fluid-absent nor hydrous melting of TTGs at pressures up to 15 kbar can fully satisfy the required parameters of the melts. The influx of K and Na seems to be needed for the formation of the A-type granites. Data on the melting of TTGs in presence of the H<sub>2</sub>O-CO<sub>2</sub> fluids containing alkali salts are absent, so far. In order to trace variations of mineral assemblages and melt composition in dependence on temperature, concentration of salts and K/Na ratio in the fluids, the experiments on interaction of a biotite-hornblende tonalite gneiss with the H<sub>2</sub>O-CO<sub>2</sub>-(K, Na)Cl fluids at 5.5 kbar and 750 and 800°C were performed. The H<sub>2</sub>O-CO<sub>2</sub>-KCl fluids provoke melting only at 800°C. Addition of NaCl assists to melting at 750°C. The increase of the chloride/(H<sub>2</sub>O+CO<sub>2</sub>) ratio in the fluids results in formation at 800°C of the rhyolitic melts with Al<sub>2</sub>O<sub>3</sub> < 13.5 wt. %, CaO < 2 wt. %, K<sub>2</sub>O+Na<sub>2</sub>O > 7 wt. %, FeO/(FeO+MgO) > 0.8, K<sub>2</sub>O/Na<sub>2</sub>O > 1, moderately enriched in Cl (0.2-0.6 wt. %). The melt composition correlate with the coexisting mineral assemblages, varying in the sequence Opx+Amp+Pl+Ti-Mt+Ilm → Opx+Cpx+Ilm → Cpx+Kfs+Ilm. Stabilization of Cpx and Kfs at the high chloride/(H<sub>2</sub>O+CO<sub>2</sub>) ratio in the fluids corresponds to the decrease of CaO and Al<sub>2</sub>O<sub>3</sub> contents in the melts, while increase of the Cl content in these melts promotes the FeO/(FeO+MgO) ratio. Stability of pyroxenes at moderate and high chloride/(H<sub>2</sub>O+CO<sub>2</sub>) ratios in the fluids reflects low *a*<sub>H<sub>2</sub>O</sub> in the melts, i.e. their apparent “dryness”. These characteristics are similar to the A-type granites. At 750°C, the H<sub>2</sub>O-CO<sub>2</sub>-(K, Na)Cl fluids produce trachytic melts, which model syenites, monzonites and other alkalic basic counterparts of the A-type granitic complexes. The experiments support the model for formation of these complexes by crustal melting during high-grade metamorphism in presence of the aqueous-carbonic-salt fluids fluxing in the extensional environments.