ESRF	**Experiment title:** Caesium and iodine in solution in asingle fluid inclusions: 2 elements of major environmental concern	**Experiment number**: ME-54
Beamline: ID22	**Date of experiment**: from: 9-avr-00, 7:00 am to: 11-avr-00, 7:00 am	**Date of report**: 8-aug-00 *Received at ESRF:*
Shifts: 6	**Local contact(s)**: Alexandre SIMIONOVICI	

Names and affiliations of applicants (* indicates experimentalists):

Pascal PHILIPPOT, CNRS, Université Paris 7

Bénédicte MENEZ, Lab. Pierre Süe, CEA, Saclay

Julien FORIEL, Université Paris 7

Alexandre SIMIONOVICI, ESRF

Report:

The aim of experiment ME-54 was to confirm the presence of I and Cs in solution in individual inclusions from the Streltsovka deposit (Russia). Proving this would have been of high environmental concern owing to the higly volatile nature of the uranium fission product CsI. As discussed in the previous report of experiment CH-626, where we have showed the presence of U, Pb, Zr, La, and Sr in the same fluid inclusion (Philippot et al., 2000, in press; **see Abstract below**), the use of an incident energy of 35 keV was a prerequisite to dose these two elements because of their very low count rates and of overlaping of the iodine Lα X-ray with that of Ca Kβ X-ray (see figure 1). Unfortunately, because experiment ME-54 has been scheduled together with experiment IN 127 (industrial purposes) for which an incident energy of 22 keV was required, it was impossible to adapt the Compound Refractive Lens (CRL) to both energies (22 and 35 keV) due to timing constraints. (The experiment carried on the line ID22 comprises a Fresnel Zone Plate (FZP) for energies lower than 20 keV and a CRL for energies higher than 22 keV.) As a consequence, results of the analysis are not conclusive. Specifically, although iodine was detectable in most inclusions (Table 1), we were not able to characterize Cs with a sufficient degree of precision.

Figure 1. X-ray spectrum of a fluid inclusion from the Streltsovka U-deposit

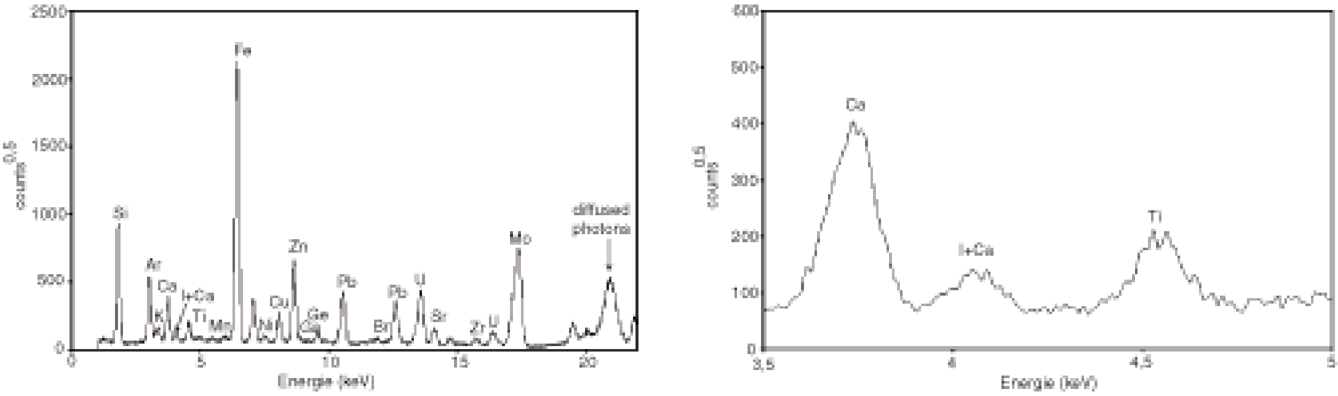


Table 1. Counts for Iodine and Uranium in samples from the Streltsovka U-deposit after beam absorption and host crystal signal corrections.

	I	U
7c56-I	3	3549
7c56-IIIc1	32	4525
7c56-IIIc2	20	2884
7c56-IIIc3	68	1065
7c56-IIIc3		26162
7c56-IIId2	11	280
7c56-VII	26	6291
ST56	14	1235

In order to compensate this situation, we decided to analyze samples containing fluid inclusions that can be considered as representative of the original fluid involved in the formation of the volcanic rocks forming the Streltsovka deposit. The Streltsovka deposit is formed by a 20 km diameter caldera comprising a 1 km thick pile of volcanics (basalt, andesite, trachydacite and rhyolite) characteristic of island arc environment. The original fluid involved in the formation of this volcanic suite was likely derived from a subducted slab. Surprisingly little attention has been paid to the trace element composition of the fluids associated with the dehydration of the subducted slab, because of the challenge of developing convincing methods for the quantitative analysis of single fluid inclusions.

In order to determine the potential composition of the subducted fluid involved in the generation of island arc volcanics as those forming the streltsovka caldera, we performed single fluid inclusion analysis of high pressure rocks that have been subducted to the depth locus of island arc magmatism and that were brought back to the surface during collisional processes. The rocks studied contain primary fluid inclusions that have been studied extensively during the last decade by the main proposer (Philippot and Selverstone, 1991; Philippot, 1993; Philippot et al., 1995; 1998; Philippot and Rumble, 2000), but not with the highly intense synchrotron light source of the ESRF, which allows heavy metal analysis with detection limits down to the ppm level.

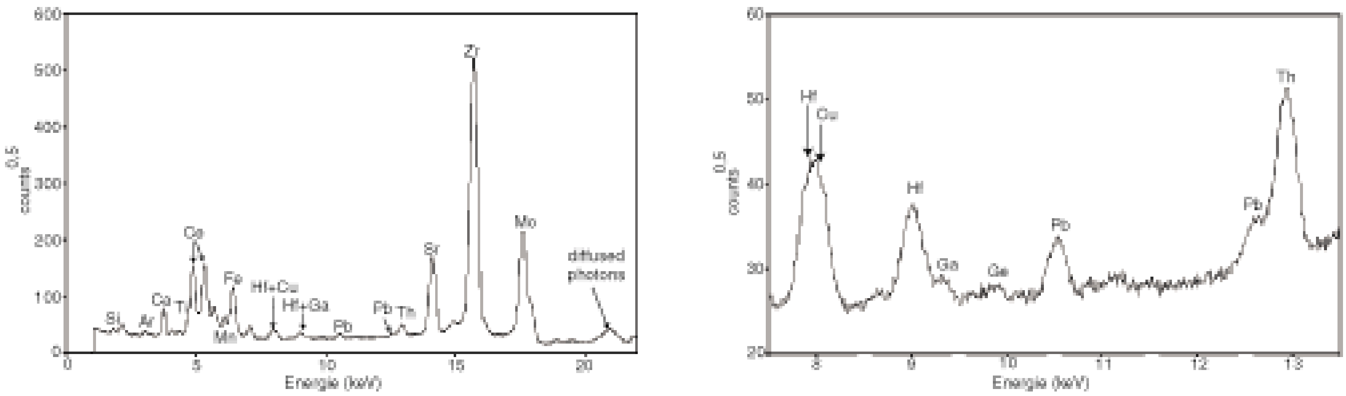
Results of these preliminary investigations are highly encouraging (Table 2 and Figure 2). Among unexpected results is the presence of Hf, Zr and Th in solution which have been considered as highly insoluble in such environments. The high content of Zr, Sr, Pb and La correlates well with the fluid present in the streltsovka volcanics. Uranium is absent in the high pressure fluid, implying that uranium was likely mobilized from the rocks surrounding the caldera due to intense fluid circulation attending volcanic activity. Th, which is present in the Streltsoka fluid, remained difficult to interpret owing to the very low Th content of both surrounding rocks and volcanics. The relatively high concentration of Th of the high pressure fluids suggests a deep origin (i.e., Th derived directly from the subducted slab?). Similar reasoning can apply to Cu and Zn, which form two main components of ore deposits associated with island arc magmatism.

These preliminary results are promising in that they offer for the first time a great opportunity to elucidate trace element recycling in subduction zone environment.

Table 2. Counts after correction for beam absorption by air and host crystal signal for high pressure samples.

	SL324-IIa	SL324-IIb	SL324-IIc	SL324-IV1	SL324-IV2
K	1562	79			
Ca	7215	2823	424	11097	33719
Fe	5912	3296	1166	11623	31618
Ni	242	20	0	6	19
Cu	4831	1101	34	1730	1926
Zn	556	145	12	101	124
Ga	48	54		12	
Br	237	98	7	38	
Sr	1869282	200623	2333	241830	82576
Zr	506033	273877	24922	583323	855571
La	1519	448	89	2396	6492
Ce	34509	13238	3522	29892	53337
Hf	1670	970	74	1733	2302
Pb	2801	610	47	651	870
Th	1968	711	143	2098	4791

Figure 2. X-ray spectrum of a fluid inclusion from a HP sample



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ABSTRACT OF THE TERRA NOVA PAPER, In press

The X-ray imaging of uranium in individual fluid inclusions

Pascal Philippot[1], Bénédicte Ménez[1], Alexandre Simionovici[2], Aliouka Chabiron[3], Michel Cuney[3], Anatoly Snigirev[2], Irina Snigireva[2]

The spatial distribution of major (K, Ca, Mn, Fe) and trace elements (Ti, Cr, Cu, As, Br, Rb, Sr, Zr, Pb, Th, U) were determined in individual fluid inclusions from quartz veins of the Streltsov uranium deposit, Russia, using synchrotron radiation X-ray fluorescence (SXRF). The analyses were performed on the beamline ID-22 Micro-FID (Fluorescence, Imaging, Diffraction) of the European Synchrotron Research Facility (ESRF, Grenoble, France). Fluorescence X-ray maps of single fluid inclusion show a relatively homogeneous distribution of most elements throughout the inclusion, whereas Fe and to a lesser extend Sr display highly localized count rates. This observation argues for the presence of minute, optically invisible, compounds that precipitated inside the inclusion. Simple model calculations indicate that relatively diluted solutions (10 to 100 ppm U) trapped at geologically relevant temperatures (e.g., 250 °C) would precipitate sub-micron sized particles. These particles would be highly reactive to the photon flux but not necessarily visible under the microscope. These results indicate that third generation synchrotron light source can be a powerful technique to study the physical processes undergone by the fluid. When combined with chemical data, this technique can help to clarify fluid transport properties in natural systems.