TRACE ELEMENTS IN IVORY COAST TEKTITES, MICROTEKTITES, AND FALLBACK PARTICLES OF THE LAKE BOSUMTWI IMPACT CRATER, GHANA: A LA-ICP-MS STUDY.

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Introduction: Various types of rock melts originate in cratering events. Their origin is still not understood in detail despite intense geochemical investigations and modeling attempts [1]. The Bosumtwi crater represents a model case for studying impact-related melt lithologies as it is the source crater for Ivory Coast (IVC) tektites, microtektites, glass fragments in suevites, and fallback particles. Results of the ICDP-Bosumtwi Drilling Project indicate that just a few lithologies are important precursor materials to the various glasses [2-4]; hence chemical differences between the glass types may reflect peculiarities of the formation processes. However, the up to 25 m thick tropical soil layer certainly was an important precursor for the IVC tektites. Here we present results of a systematic trace element study of the above-named materials.

wt%	IVC tektites	Microtektites	Fallback particles	
	n = 2	n =5	n = 22	#15
SiO_2	66.1	65.0	63.5	65.0
TiO_2	0.65	0.54	0.65	0.63
Al_2O_3	16.3	16.3	17.5	16.8
FeO_{tot}	6.5	6.6	5.3	5.9
MgO	3.8	4.9	3.2	3.3
CaO	1.2	1.4	2.8	2.7
K_2O	2.1	2.3	2.6	2.6
Na_2O	1.8	1.8	1.8	1.7
ppm				
Sc	24	17	20	21
V	154	77	123	159
Co	41	32	19	24
Ni	229	164	38	99
Rb	104	57	67	93
Sr	401	292	345	169
Y	22	17	20	28
Zr	182	123	141	150
Nb	8	5	6	7
Cs	5	2.4	3	4
Ba	904	609	570	668
La	30	23	23	36
Ce	66	47	49	73
Pr	8	6	6	9
Nd	29	22	23	36
Sm	6	4	5	7
Eu	1.4	1.1	1	2
Gd	5	4	4	6
Tb	0.6	0.5	0.6	1
Dy	4	3	4	5
Ho	0.8	0.6	0.7	1
Er	2.4	1.7	2.1	3
Tm	0.3	0.3	0.3	0.4
Yb	2.4	1.9	2.1	3
Lu	0.4	0.3	0.3	0.4
Hf	5	3	4	4
Ta	0.6	0.4	0.4	1
W	0.7	0.1	0.5	0.5
Pb	3	0.4	0.8	4
Th	5	3	4	5
U	1.3	0.4	1.2	1

Table 1. Average major and trace element contents of IVC tektites, microtektites, and fallback particles.

Samples and analytical techniques: So far we have analyzed 2 IVC tektites, 5 optically quite similar yellow-brownish microtektites, and 23 glassy fallback particles [5]. Major elements were measured with a JEOL JXA 8900 Superprobe at the Interdisciplinary Centre for Electron Microscopy and Microanalysis ICEM WWU (15 kV acceleration voltage, 5 nA sample current, 5µm defoc. beam). Trace elements were analyzed with an Element2 LA-ICP-MS (5Hz, 8-9J/cm^2; Inst. f. Mineralogie WWU) using Si as internal, and NIST 612 as external standard. For tektites, 3 spots (∅ 60 µm), and for microtektites and fallback particles 1 spot (∅ 35 µm) per sample were measured.

Results: Average major and trace element data of the glasses are given in Tab. 1. REE are shown together with data for potential precursor materials in Fig. 1. In agreement with data by [7-9], tektites have a quite restricted, microtektites and fallback particles a wider compositional range. Most fallback particles plot in the field for microtektites (green, Fig. 1). The chemical variations of Ni (4–99 ppm), Co (8-27 ppm), and Zr (125-159 ppm) contents observed for the fallback particles are also large. All Ni concentrations are lower and only the highest concentrations of Co and Zr overlap with data by [9]. Both data sets agree on a wide scattering in the Ni/Co ratio. We observe ratios

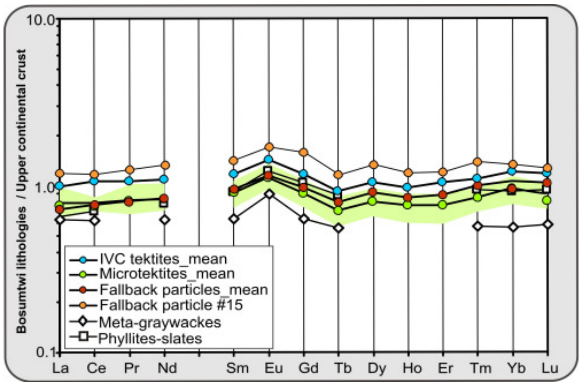

Figure 1. REE patterns for IVC tektites, microtektites, and fallback particles normalized to UCC data by [6]. The green field displays the range of microtektite samples. Meta-graywackes and phyllites-slates are target lithologies drilled in the ICDP project ([4], average).

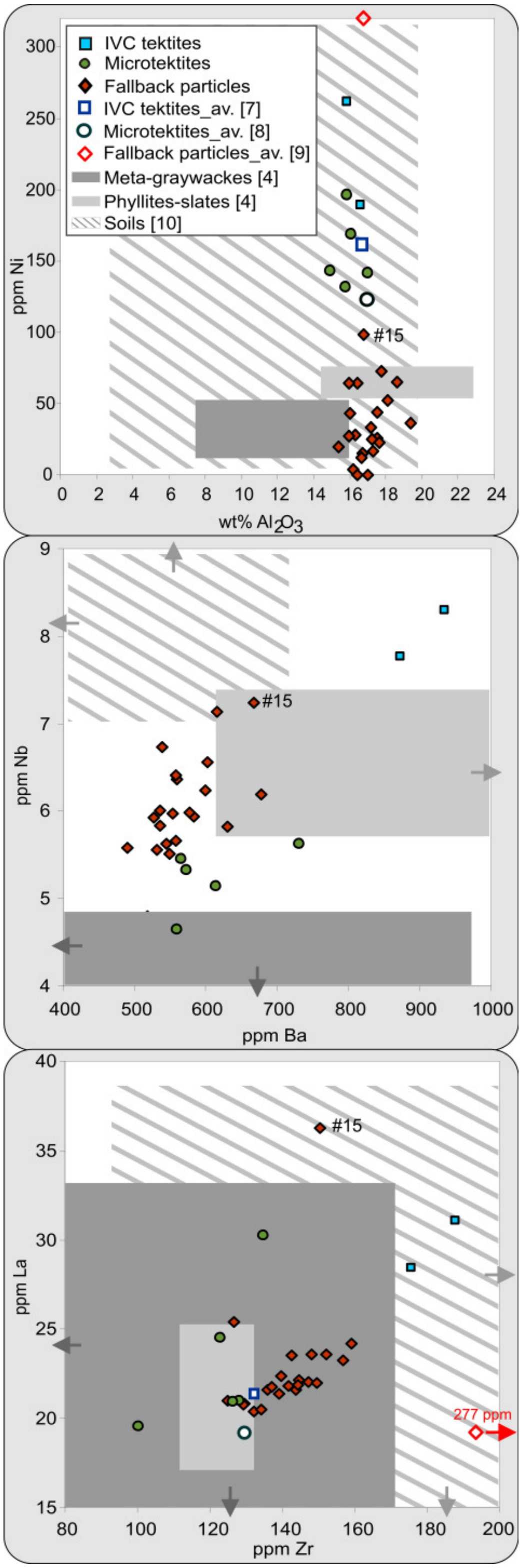

Figure 2. Trace element discrimination diagrams for IVC tektites, microtektites, and fallback particles in comparison to published data for impact glasses and potential target materials. Arrows mark ranges in excess to the scale.

between 1 and 4 (up to 16 in [9]). IVC tektites and microtektites have Ni/Co ratios between 5 and 6 (own data and [7, 8]). Low Ni and Co concentrations discriminate fallback particles from IVC tektites and microtektites.

Compared to all other fallback particles, particle #15 has significantly higher REE, Ni, Rb, Y, Nb, Cs, and Pb concentrations, and a rather low Sr concentration (Tab.1, Fig. 2). Tektites are characterized by particularly high concentrations of the refractory elements Ba, Zr, and Nb; our new data even extent the range given by [7]; the results for microtektites are in good agreement with published data [8]. Interestingly, the average REE composition of fallback particles (without #15) and microtektites correspond well with that one for phyllites-slates [4], while meta-graywackes have lower REE contents than the impact glasses.

Discussion: The high spatial resolution of the LA-ICP-MS technique allows to reveal compositional heterogeneities in the various types of impact-melt glasses as well as differences between IVC tektites, microtektites and fallback particles. The IVC tektites show a homogeneous composition consistent with a formation at extreme pT conditions from the uppermost target layer [1]. In case of Bosumtwi, presented data are in agreement with a soil contribution to the tektite composition (Fig. 2). A soil component is also indicated by Sr-Nd isotope systematics [Luetke et al., unpublished data]. The heterogeneities among the fallback and microtektite groups suggest that various precursor lithologies in variable mixing proportions may have contributed to the respective melts. The Nb-Ba data excludes however a contribution from soil (Fig. 2). The relatively large scatter in Ni/Co ratios observed for the fallback particles is not yet understood and may require a contribution from a further target rock.

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