TRACE ELEMENT DATA HELP UNDERSTANDING THE ORIGIN OF LAKE BOSUMTWI CRATER RELATED GLASS (IVORY COAST TEKTITES, MICROTEKTITES, FALL-BACK PARTICLES, SUEVITE GLASS).

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Introduction: The Bosumtwi impact structure, Ghana (D ~10.5 km; age 1.07 Ma [1]), is an excellently preserved unique terrestrial crater: It is not only source of a tektite (Ivory Coast tektites – IVC [2]) and a widespread microtektite (IVC-MT) strewn field [3] but also has preserved glass particles (FBG) in the fall back layer topping the breccia sequences inside the crater [4]. Moreoever, suevites in the ejecta blanket around the crater carry impact glass shards (BOT 12 [5]); in addition, outcrops and cores of ICDP wells provide a nearly complete spectrum of target rocks forming precursor lithologies [5-7] of these four groups of impact glasses. Given these unrivaled facts, we can address geochemical processes during formation and ejection of the glassy lithologies.

Samples and Analytical techniques: For constraining the target variations we used a number of bed rocks surface and drill core samples and three soil samples [8], characterized by XRD (WWU; FSU). Target rock and glass lithology samples were examined in thin sections with optical and electron optical microscopy followed by microchemical analysis of major element with the EMP JEOL JXA 8900 Superprobe (WWU), and of 42 trace element with LA-ICP-MS (UP193HE, Element2; WWU) using a spot size of 60 µm or in the case of IVC-MT, and FBG of 40 µm (for details, see [9]). In addition, we performed Rb-Sr and Sm-Nd isotope analysis, and DEGAS analysis for determination of gas content and degassing behavior.

Results and Discussion: The four internally rather homogeneous groups of glass (IVC, IVC-MT, BOT 12, FBG) show variations in MgO and Na_2O, with marked calcium depletion in IVC and IVC-MT; we interpret this to reflect the composition of precursor lithologies. These were constrained by Sr-Nd systematics to greywacke, the most common target rock [10]. Some greywacke samples have very high contents of Ni, Co, and Cr, reflecting contributions of the ore-bearing meta-volcanics in the Bosumtwi region.

The IVC, IVC-MT, and BOT 12, yet not the FBG group have similar high abundances of "meteoritic tracer elements" Ni, Co, and Cr, obviously inherited from the target, that mask any possible contribution of the projectile to the impact glasses. Trace element patterns show little variations within each group of glass, but differences exist between the groups: only IVC samples show a minor Ce anomaly, pointing to alteration in the precursor material which is assumed to be soil [11]. Compared to the average composition of the upper continental crust (UCC [12]), "moderately volatile elements"; i.e., the alkali elements, B, Cu, Zn, As, Pd, Ag, Sn, Sb, Pb, and Bi are depleted in the glass to different degrees (Fig. 1). The spidergram of Fig 1 illustrates that IVC-MT, and IVC are strongly, and FBG to a lesser degree depleted in these elements. In addition, alkali elements are generally depleted compared to the upper continental crust, while, interestingly Ga, and Ge in the glass samples plot above the Ga, and Ge abundances in the UCC. The BOT 12 glasses show do not show these features (Na, Zn, As), or display just a less severe depletion (Sb, Pb). A strong depletion is also documented in Cu (IVC, IVC-MT), while BOT 12 is significantly, and FBG just a little bit enriched in Cu compared to UCC. Depletion in V is found for the IVC-MT group. It is obvious that these patterns reflect the different temperature history of the different groups of glass. Moreover, these geochemical signatures are in good accordance with isotope fractionation reported to occur in tektites for K, Zn, and Cu [13-15].

Conclusions: Despite the fact, that ICDP drilling resulted in a general deficit of impact melt in the Bosumtwi impact structure [16], the melt lithologies available yielded extremely valuable data. The totally dry IVC-MT and IVC homogenized at the highest T, evolved under reducing conditions [10], and followed a T path causing substantial loss of trace elements; this loss is less distincted in FBG. Suevite glass originated at much lower T, as indicated, for example, by mineral inclusions. Considering the origin, i.e., formation and transport of melt in the expanding ejecta plume [17], we may consider models for the Trinity fall-back glass spherules [18, 19].

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Fig. 1. Spidergram showing concentrations of some major and trace elements the four Bosumtwi related groups of glass – IVC, IVC-MT, FBG, BOT 12 normalized to the average composition of (UCC;[12]). Note the strong depletion in moderately volatile elements (Ag and Cd are not shown, as the data for nearly all laser spots are well below detection limits). The most pronounced depletion is displayed in the IVC-MT group, followed by IVC, and FBG. The effect is much less in BOT 12. In IVC, IVC-MT, and BOT 12 glass, a distinct enrichment appears in Cr, Co, and Ni which is lacking in FBG (modified after [10].