BERYLLIUM-10 IN IVORY COAST TEKTITES. F. Serefiddin[1], G. F. Herzog[1], and C. Koeberl[2], [1]Dept. of Chemistry & Chemical Biology, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854-8087, USA (serefif@rutchem.rutgers.edu), [2]Institute of Geochemistry, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria. (christian.koeberl@univie.ac.at).

Introduction: Previous studies of Australasian tektites used ^{10}Be concentrations to constrain the location and characteristics of the source material [1]. The average value of ^{10}Be (corrected to time of formation (TOF) 0.77 My ago) in Australasian tektites is $143\pm50\times10^6$ atoms/g. This average is comparable to values measured in near surface source materials, such as soils (terrestrial) or sediments (marine and terrestrial).

The Ivory Coast tektites are regular (splash-form) tektites formed as a result of the impact event that created the Bosumtwi Crater 1.07 My ago (Figure 1) [2]. The land-based tektite strewn field is an area 40 km in radius approximately 125 km north of Abidjan. The entire tektite strewn field including microtektites extends off the coast of West Africa. If Ivory Coast tektites also formed from surficial materials as did the Australasian tektites, then we would expect them to contain similar concentrations of ^{10}Be.

We present the results of AMS measurements of ^{10}Be concentration in the Ivory Coast tektites. Our primary objective is to consider possibilities for source materials and other factors that determine ^{10}Be concentrations in the tektites.

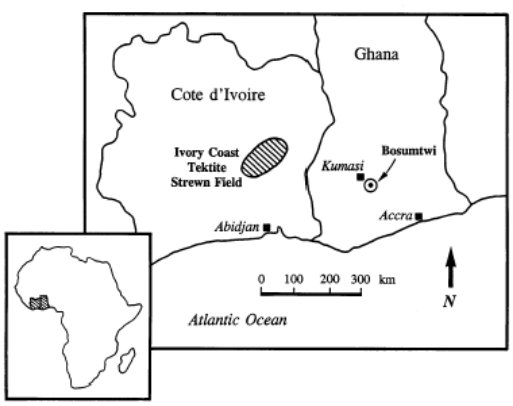

Fig. 1. Ivory Coast tektite strewn field relative to Bosumtwi Crater (at 06°32'N and 1°25'W) in Ghana [3].

Experimental Methods and Results: We obtained samples of 9 Ivory Coast tektites. Three of them, 2096, 3395, and 3396, are from the collection of the Museum National d'Histoire Naturelle, Paris; samples 8901 and 8902 were received from the University, Abidjan, Ivory Coast. The IVC samples had been analyzed for chemical and isotopic composition by Koeberl et al [2]. Samples beginning with IV0 are in the collection at Rutgers University. The tektites were analyzed for ^{10}Be.

Table 1. ^{10}Be concentrations (10^6atoms/g) of tektites from Ivory Coast.

Sample ID	^{10}Be Measured	^{10}Be TOF
IVC2096	24.1±0.5	47.1±1.0
IVC3395	5.6±0.3	7.0±0.4
IVC3396	25.3±1.3	49.7±2.7
IVC8901	40.6±0.8	82.9±1.8
IVC8902	13.3±0.3	23.8±0.5
IV06022304	19.9±0.9	38.0±1.7
IV07022304B	12.7±0.7	22.5±1.3
IV07022304D	17.0±0.9	31.8±1.6
IV07022304F	17.2±0.9	32.1±1.8

We processed 500–1500 mg of each tektite to extract ^{10}Be using standard ion exchange procedures [4]. ^{10}Be measurements were made at the accelerator mass spectrometer at PRIME Lab, Purdue University. Samples of a powder prepared from the Dhurmsala meteorite, for which the ^{10}Be activity is well known, were also processed and measured as a reference. The ^{10}Be/^{9}Be blank for the chemical procedure was less than 2×10^{-14} (atom/atom). The measured ^{10}Be contents are in a range of 5.6 ± 0.3 - $40.6\pm0.8\times10^6$ atoms/g (Table 1), with statistical uncertainties of 2-5%. The ^{10}Be activities of Dhurmsala measured with the IVC samples were found to be consistent within 5% of the value 21.3 dpm/kg, an average of 50 measurements made from four independent laboratories. The ^{10}Be activities for the IV0 samples were determined using a correction factor of 1.34 to compensate for a systematic offset from the Dhurmsala data.

Discussion: Previous work has shown that Australasian tektites formed from loosely consolidated, relatively fine-grained surface materials that adsorbed ^{10}Be produced in the atmosphere and carried to the surface by precipitation [1]. We expected that Ivory Coast tektites would contain meteoric ^{10}Be and, perhaps, a component produced by in-situ cosmic ray irradiation. If we assume no pre-exposure of surface materials to cosmic rays, then the concentration of meteoric ^{10}Be at the time of formation, N_o, can be calculated using the equation

$$N_o e^{-\lambda t} = N_m - P_{10}\left(1 - e^{-\lambda t}\right) \quad (1)$$

where N_m is the measured ^{10}Be concentration, t the time since tektite formation, 1.07 My, and P_{10} the in-situ production rate, here taken to be 6.05 atoms (g $SiO_2)^{-1}$ yr^{-1} for ^{10}Be in terrestrial materials [5]. The cosmogenic (in situ) contribution ranges from 7-33%. This is the maximum contribution because in situ production may be interrupted by intermittent periods of burial and because it is lower below the surface. In the Australasian tektites the meteoric contribution is even more dominant, >99% of the total inventory.

The ^{10}Be concentrations in the tektites calculated for time of formation are in the range 7.0±0.4 – 82.9±1.8×10^6 atoms/g (Table 1). The average 34.0×10^6 atoms/g is 4-5 times lower than the corresponding average for Australasian tektites and comparable to ^{10}Be concentrations measured for bulk soils from the Ivory Coast, 4.4 – 150×10^6 atoms/g [6]. It also overlaps the ranges of ^{10}Be concentrations measured in soils and riverine sediments from comparable latitudes (1-10°N) in the Amazon Basin (32 - 40×10^6 atoms/g [7]). Relative to these materials, tektites may have lower ^{10}Be because they were formed from materials lower in the soil column or because they were mixed with materials with very low (<10^7 atoms/g) concentrations of ^{10}Be such as bedrock.

Several factors may explain the difference between the ^{10}Be concentrations of Australasian and Ivory Coast tektites. 1) Given equal concentrations of ^{10}Be in the surface materials, we would expect to see about 30% less ^{10}Be in the older Ivory Coast tektites due to nuclide decay. A 30% decrease is too small to explain the observed difference. 2) Australasian tektites probably formed from materials - either loess-like soils or coastal sediments - exposed to precipitation or standing water for a long period of time. Soils generally contain ^{10}Be concentrations 75% lower than marine and hemipelagic sediments [1]. Thus, Ivory Coast tektites could have formed from local soils. 3) The depth sampled in the column of material forming the tektites can also influence ^{10}Be. ^{10}Be concentrations in Ivory Coast soils decrease from 150×10^6 atoms/g at 1.8 m below the surface to 40×10^6 atoms/g at 10 m [8]. Until ^{10}Be is measured in soils near the Bosumtwi Crater, we can use Ivory Coast soils as a comparison because ^{10}Be production and deposition at the two sites are expected to be similar [9]. The impact may have excavated soils from even greater depths during the formation of tektites. The same observation likely applies to the source region of the Australasian tektites, however, and as their ^{10}Be concentrations are larger, the depth effect probably does not entirely explain our observation. 4) Climate, geomagnetic intensity and solar variability can affect ^{10}Be deposition and production rates over time. A core from about the same latitude in the Caribbean Sea (11°N) shows a strong relationship between ^{10}Be concentrations and geomagnetic reversals as well as between ^{10}Be concentrations and interglacial/glacial periods [8]. ^{10}Be concentrations increase at the times of geomagnetic reversals and during the warmer interglacial periods and vary within a range of 200 – 1400×10^6 atoms/g over 3.5 My. The Australasian tektites formed 0.77 My ago, a time when ^{10}Be production peaked due to lower geomagnetic field (Brunhes/Matuyama geomagnetic reversal) and warmer, wetter climate conditions (interglacial isotope stage 19) [10]. The Ivory Coast tektites, with lower ^{10}Be, correspond with a time between magnetic reversals and colder, drier climate (glacial isotope stage 20). We estimate that these effects would have lowered ^{10}Be deposition rates by about 40%.

Conclusions: ^{10}Be concentrations of Ivory Coast tektites are consistent with formation from mostly near surface sediments or soils. The Ivory Coast tektites have ^{10}Be values on average 77% lower than the Australasian tektites. Several factors may contribute to variability in tektite ^{10}Be concentration: 1) age of sample, 2) nature of source materials, 3) depth of sample in soil column, and 4) environmental conditions at time of formation. Individually these different factors seem unlikely to account for the full difference in ^{10}Be concentrations between the Ivory Coast and Australasian tektites. However, a combination of these factors can readily explain up to 80% of this offset. Mixing of sediments and soils with low ^{10}Be materials such as deposits eroded from bedrock may also explain the lower values in the Ivory Coast tektites. Measurements of ^{10}Be in soils collected at different depths near the Bosumtwi Crater would be more appropriate than Ivory Coast soils to compare with tektite results. Ongoing geophysical investigations of the Lake Bosumtwi floor should provide a transient crater depth and hence an upper bound on vertical extent of the source region [11].

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