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Reconstruction of lake-level fluctuations in Lake Issyk-Kul (Kyrgyzstan) through geomorphological en seismostratigraphic analysis of deltas

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In 2002, Naudts (M.Sc. thesis, UGent) succeeded in reconstructing a Late-Cenozoic relative lake-level curve for Lake Issyk-Kul by using partially and fully buried delta deposits in the eastern part of the lake as proxies for lake level. His data consisted of dense grids of high-resolution reflection seismic profiles that were acquired in 1997 and 2001.

The aim of the present study was to evaluate the possible impact of tectonics on this relative lake-level curve. To this end, a second relative lake-level curve was to be derived –using the same strategy and the same seismic data set– but this time based on partially and fully buried delta deposits in the western part of the lake. Comparison of both curves was thought to allow filtering out any tectonic component and to gain a better understanding of the possible causes of lake-level fluctuations in Lake Issyk-Kul.

The first step in the seismic interpretation was the establishment of a robust seismic sequence stratigraphy by subdividing the sedimentary infill in seven depositional sequences separated by sequence boundaries. Isochrone maps were constructed to interpret the paleomorphology of the sequence boundaries (e.g., channels, delta fronts) and isochronopach maps, combined with seismic-facies interpretations, to interpret depocentres and the exact location and extent of progradational delta lobes. In the next step, the absolute depth (below present lake surface) was measured of the offlap breaks in each of these progradational delta lobes. This depth represents paleo-wavebase and thus approaches paleo lake-level. Based on these interpretations, a new relative lake-level curve was constructed. This record shows a succession of 8 distinct lake-level stages with levels between 504 and 155 m below present lake level.

Comparison of both relative lake-level curves (i.e., based on the depth of the eastern deltas and the western deltas) shows that the general trends in both records are comparable, both for what concerns the succession of rises and drops in lake level, and for the exact depth of the level for individual stages. However, the records also exhibit some dissimilarities. Some lake-level stages appear to be missing from the eastern lake-level curve. This could be due to a number of factors: e.g., temporary diversion (possibly tectonically controlled) of one of the delta-building tributaries, temporary changes in sediment yield at one of the delta-building tributaries, or simply incomplete seismic coverage resulting in "non-detection" of one of the delta lobes.

For what concerns the cause of the lake-level fluctuations, we can exclude intra-basin tectonic activity (e.g., uplift, subsidence), since the seismic data show no evidence at all of tectonic deformation in the eastern or in the western part of the lake. The most likely cause of the Late Cenozoic lake-level fluctuations in Lake Issyk-Kul is therefore climate change. Further investigation will reveal more of the climatic causes of the lake level fluctuations.

Geochemistry and distribution of platinum group elements in the impact structures of Bosumtwi (Ghana, Pleistocene) and Gardnos (Norway, boundary Proterozoic-Paleozoic).

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1. Goal

The aim of this study was to identify the projectile, in other words the kind of meteorite, responsible for the formation of the Gardnos (Norway; 500-650 Ma old) and the Bosumtwi (Ghana; 1.07 Ma old) craters. This identification can be accomplished by determining the geochemical signatures left behind by the meteorite in the lithologies of these impact structures. Characterization of the impactors provides information on the frequency and on the origin of the different planetary bodies (asteroids, comets) that have crossed the Earth's orbit through geological times.

The Gardnos structure, which is relatively easily accessible in the field, was sampled for impact melt material. The Bosumtwi crater on the other hand was drilled in the Summer and Autumn of 2004 by the *International Continental Scientific Drilling Project (ICDP)* [http://dc110.gfz-potsdam.de/sites/bosumtwi]. This study focuses on the samples of cores LB-07A and LB-08A, drilled near the centre of the crater. The siderophile platinum group elements (PGEs) Os, Ir, Ru, Pt, Rh and Pd are exceptionally fit for the identification of the projectile type, as a result of the high concentrations in which they occur in most of the meteorites, compared to their limited occurrence in terrestrial crustal rocks. The PGE elemental ratios can be used to link the studied impact structures with their characteristic PGE 'fingerprints' to a certain type of meteorites, according to the method described in Tagle & Claeys (2005).

2. Analytical methodology

The determination of the PGEs was accomplished by using a NiS Fire Assay, in combination with ICP-MS (Inductively Coupled Plasma Mass Spectrometry), according to the procedure described by Plessen &

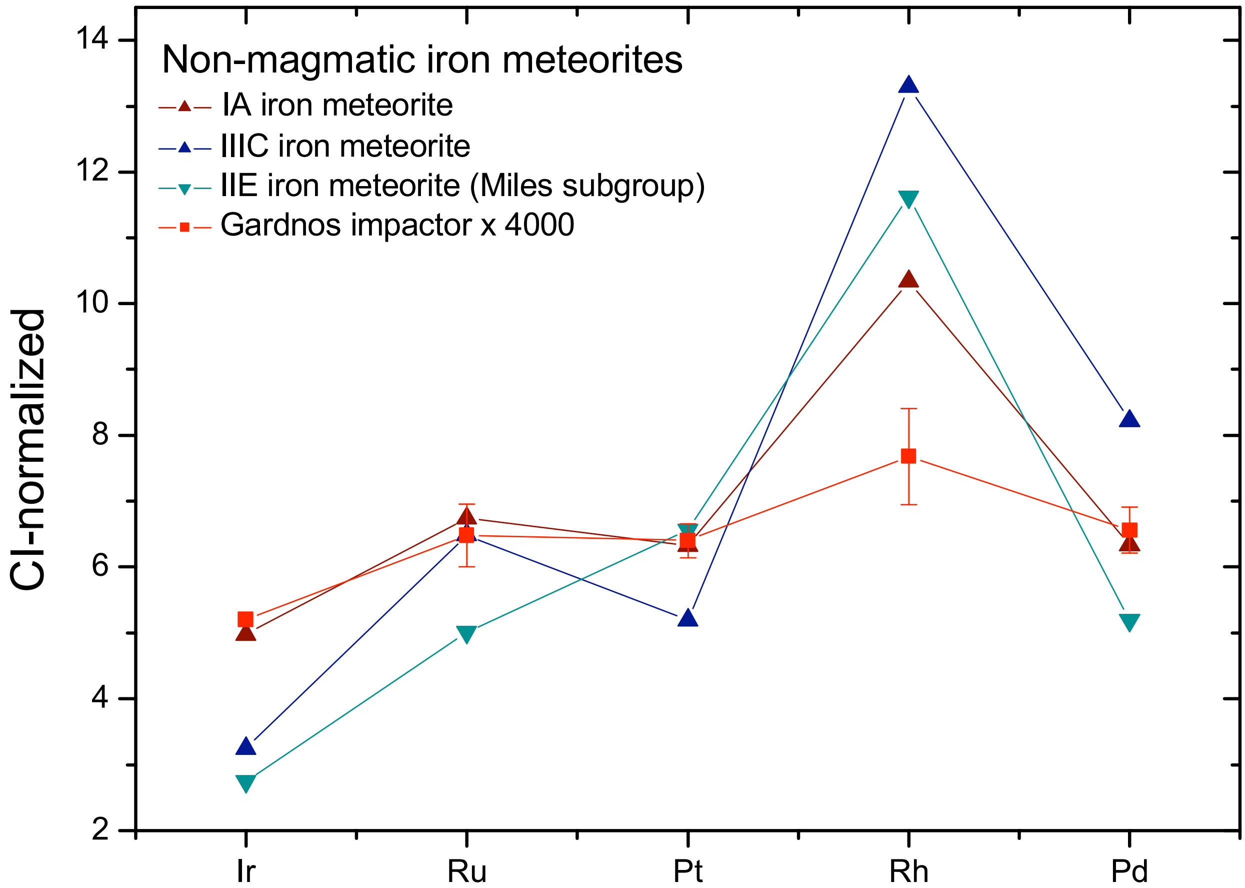
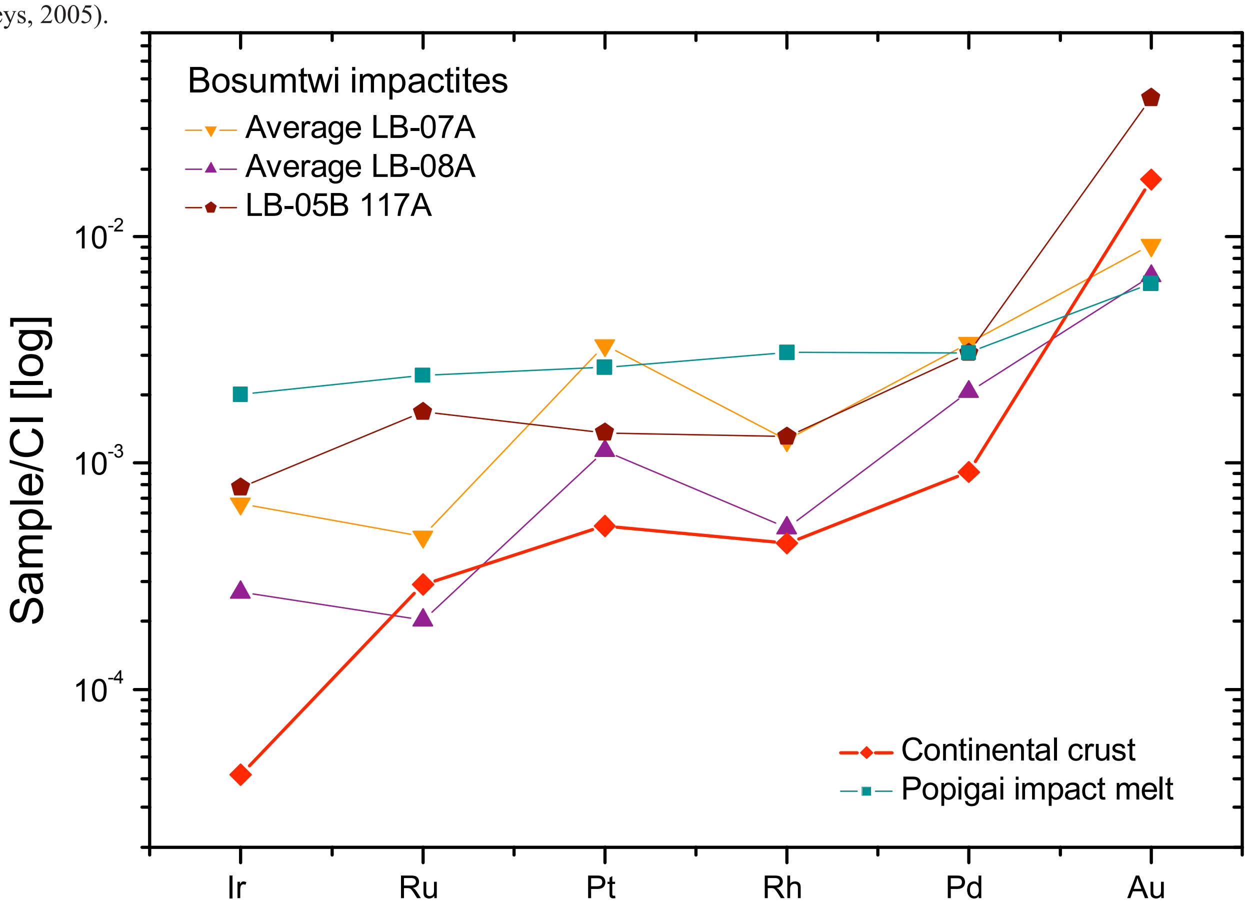


Figure 1A & 1B. 1A: CI-normalized PGE concentrations of the metallic phase of non-magmatic iron meteorites. The concentrations of the averaged Gardnos samples were multiplied with a factor 4000 in order to compare the patterns graphically. 1B: CI-normalized PGE and Au pattern for the averaged values of the samples from drill cores LB-07A and LB-08A, the values of sample LB-05 117A, the average continental crust and the average values of Popigai (Tagle & Claeys, 2005).



Erzinger (1998). The advantages of this technique include, for instance, the low detection limits (e.g. ~55 ppt Ir), the very good reproducibility and the relatively short duration of the analyses (all PGE, except for Os are measured at the same time). A database that contains the PGE compositions of more than 1000 meteorites was used for the identification of the projectile. The PGE elemental ratios, acquired from the analyzed samples by plotting the different PGEs against each other, are used to attain the characteristic signature of the impactor. The slope of the regression line in the plot of e.g. Ir versus Rh reflects the impactor characteristic elemental ratio. As a result of the direct comparison of the elemental ratios of the impact melt with the elemental ratios of different meteorites, the type and origin of the impactor can be documented.

3. Results

The PGE pattern of the Gardnos structure samples, in combination with the Ni/Ir, Cr/Ir and Ni/Cr ratios, indicates the contamination by a rather special kind of meteorite: a non-magmatic iron meteorite, type IA or IIIC, with a diameter of about 200 m (Fig. 1A). As a result of the low meteoritic contamination in the crater lithologies, the projectile type responsible for the formation of the Bosumtwi crater could not be identified. The obtained PGE signatures resemble those of the Earth's crust. The high PGE concentrations in the target rocks, Proterozoic metasediments containing gold-sulfide mineralizations (Oberthur et el., 1994), dominate the signal (Fig. 1B). One extra sample, out of the upper most impact ejecta, recovered from drill hole LB-05B (the fall-back layer) shows a different pattern, more like that of chondrites. Towards the future, more elaborate studies on these ejecta layers, inside and outside the crater, will perhaps produce more information on the projectile responsible for the formation of the Bosumtwi crater.

4. References

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Geology and mineralogy of the zeolite deposits of the western Cayo Formation, Ecuador

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The Ecuadorian coastal province is composed of collection of Mesozoic terranes accreted to the Ecuadorian plate margin during the upper Mesozoic to Palaeogene. This study investigates the

the zeolite deposits of the Cayo Formation, a 3000m thick, mixed volcaniclastic-detritic rock sequence, product of Upper Cretaceous intra-oceanic island arc volcanism deposited on top of the Piñon terrane and accreted to the Ecuadorian margin during the Palaeogene.

The western outcrop has been studied through large-scale sections; the eastern outcrop area has been investigated in greater detail through several small-scale sections. Pyroclastic flow and surge deposits were recognized to constitute a substantial part of the Cayo Formation, a proximal deposition environment close to the volcanic source is proposed for the examined sections.

The results of a combined qualitative and quantitative XRD analysis, optical microscopy, H-CL microscopy, SEM-EDX analysis and EMPA show the Cayo Formation to be an economically promising zeolite deposit with an exceptionally large outcrop area over a 1000 km². Zeolite grades over 70% are achieved in tuffs; associated volcaniclastic lapilli-tuffs contain 30-50% zeolite. In the western area a Ca-heulandite-clinoptilolite-mordenite zeolite mineral assemblage dominates the entire formation. In the eastern area a similar Ca-heulandite-clinoptilolite-mordenite zone can be found in the top of the Cayo Formation, but in contrast to the western Cayo Formation the dominant mineralogy shifts towards the base of the formation to a laumontite-albite assemblage and eventually to an albite assemblage. Here, also a smectite-chlorite transition takes place from top to base, supposedly concurrent with albitisation of primary plagioclase.

A burial zeolitisation model is proposed in which the eastern Cayo Formation has been more deeply buried in the fore-arc basins as the western part and has experienced the influence of a nearby volcanic heat source. The most important occurring alteration reactions are the reaction of low-grade to higher-grade zeolites, albitisation and smectite-chlorite transformation. Dehydration reactions of early-formed hydrous zeolite and clay minerals combined with the extensive albitisation of volcanogenic plagioclase has lead to the expulsion of an upwards-directed Ca-rich fluid flow throughout the volcaniclastic pile resulting in the precipitation of a late secondary calcite phase in free pore-space, fissures and faults.

The relationship between the occurring smectite-chlorite transition, the albitisation process and the successive zeolite mineral assemblages poses a very interesting subject for future research relating to the P-T history of volcaniclastic deposits.