

Status of the impact crater age database

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The Earth impact crater database (<http://www.unb.ca/passc/ImpactDatabase/>) includes a total of 174 confirmed impact structures. Ages listed in the database are based on dates recommended in the most recent published papers. Precise and accurate age constraints are crucial in (1) correlating causes and effects on the bio- and geosphere for these catastrophic processes, (2) better constraining the impactor flux through geological time and evaluation of potential impact periodicity, (3) calibrating the absolute chronostratigraphic time scale, and (4) calibrating the age of within-crater continental sedimentary deposits (e.g., for regional paleo-climatic analysis).

Of the 174 confirmed impact structures only a few have ages constrained precisely enough (mostly using radioisotopic techniques, e.g. U/Pb and ⁴⁰Ar/³⁹Ar), with 26 ages having a stated precision better than 2% and 15 ages with a precision better than 1%. Yet, even in this very restricted subset of the database the accuracy of some of these ages can be challenged and probably improved based on more detailed and statistically more rigorous interpretations. Although geochronologists are often circumspect and advise caution in accepting calculated ages, these ages tend to propagate into the literature without further critical evaluation and become “robust” and widely accepted ages. A quick review of the age data of the 26 short-listed structures suggest that 11 ages seem accurate, 13 are at best ambiguous, and 2 are not well characterized and should not be reported with any uncertainty. We report examples of misleading ages and/or age uncertainties (e.g., poor stratigraphic constraints, data over-interpretations, ambiguity due to inconsistent results) and highlight the robustness of 11 well defined ages. We also provide some suggestions (see also [1]) based on observations and modeling, in order to obtain better ages. This brief review should be interpreted as a call for drastic qualitative and quantitative improvements of the crater age database in the near future.

[1] Jourdan *et al.*, this volume

Arsenic uptake and release on sulfide nanoparticles

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Descriptions of molecular-level processes that control the uptake and release of As on sulfide nanoparticle surfaces were obtained from microbeam, spectroscopic, and quantum mechanical modeling techniques.

The precipitation of As-sulfide phases on nanoparticulate mackinawite (FeS) is identified as a possible mechanism for As(III) immobilization under anoxic conditions (Gallegos *et al.* 2007). A major challenge in identifying As-sulfide growth phases is their nanoscale dimensions. High-angle annular dark field scanning-TEM and energy-dispersive X-ray spectrometry were used to identify amorphous AsS phases precipitating on FeS nanoparticles after As(III) adsorption at pH 5. The oxidation state of As in the surface As-sulfide precipitates was determined to be “realgar-like” from X-ray photoelectron spectroscopy results showing an As 3d binding energy of 43.0 eV.

The reverse process, the oxidative dissolution of realgar (As₄S₄) and orpiment (As₂S₃) nanoparticles, is a mechanism by which As is released back into natural waters. *Ab initio* quantum mechanical methods were employed to describe indirect electronic perturbations (proximity effects) between surface adsorbates on As₄S₄ nanoclusters. Proximity effects between O and (OH)⁻ ion adsorbed on a single As₄S₄ cluster were determined to be on the order of 1 eV, depending on the O-(OH)⁻ distance. Calculations also show that adsorption of (OH)⁻ to As₄S₄ could affect the adsorption energy of O to a neighboring As₄S₄ separated from the former by a van der Waals gap (as is the case in As₄S₄ molecular crystals). The findings suggest that As₄S₄ is more susceptible to oxidative attack with the co-adsorption of (OH)⁻ ions.

The results of this study can be used to improve adsorption isotherms and surface complexation models that describe the factors that control As concentrations in natural waters.

Reference

Gallegos T.J., Hyun S.P., Hayes K.F. Spectroscopic Investigation of the Uptake of Arsenite from Aqueous Solution by Synthetic Mackinawite. *Environ. Sci. Technol.* (submitted March 2007)