Mineralogy and geochemistry of the Neogene lacustrine sediments of Bor-Ulukışla Basin (Niğde, Turkey)

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Bor-Ulukışla Basin is a large lacustrine basin in Central Anatolia, in the south-eastern part of the Tuz Gölü Basin. Tertiary sedimentary, volcano-sedimentary and volcanic rock crop out in the area. Upper Miocene-Pliocene lacustrine sediments, composed of clastic rocks, claystone, dolostone, tuffite and evaporate, overlay Paleocene-Eocene marine clastic rocks and a Paleozoic metamorphic basement.

Detailed mineralogic and chemical compositions of lacustrine sediments were examined by X-ray diffraction, scanning electron microscopy and chemical analysis. Thickness of evaporite levels varied between different drilling wells. The composition of some levels was nearly pure, consisting of one or two evaporite minerals, i.e. halite, anhydrite, while clay, evaporite, zeolite and other silicate minerals are found together in some levels. The clastic fraction of the Bor-Ulukışla basin sediment consists of quartz, feldspar, mica and some clay minerals. The non-clastic evaporite fraction is dominated by dolomite, magnesite, halite, anhydrite, gypsum and Na-Ca-sulfate minerals (glauberite, thenardite, mirabilite, bloedite, epsomite). Gypsum is the major sulfate mineral in the upper profile of the drilling wells. In lower levels, its place is taken by an assemblage of anhydrite and other sulfate minerals. Halite is the most dominant evaporite mineral. It is present in the lower profile of the drilling wells, along with other associated evaporite minerals in the center of the basin, such as Na-Ca-sulfate minerals and zeolite minerals (analcime, cliniptilolite). Clay minerals are found in the upper levels of evaporites. The main clay mineral assemblage consists of Ca-Na-montmorillonite, sepiolite, palygorskite, illite, chlorite and kaolinite. CaO and Na_2O are the dominant element oxides in the carbonate and evaporate levels. The CaO content is between 1 and 53%, while Na_2O is between 0.5-49%. Additionally, MgO content is between 0.5 and 26.63%. Al_2O_3 and SiO_2 are generally higher in the clayey and tuffitic layers. Al_2O_3 is between 7-24%, and SiO_2 is between 29-57% in the clayey and tuffitic layers. According to the chemical and mineralogic results, the paleo-lake was saturated with Na, Ca, SO_4, Cl and Mg. These were derived from groundwater that percolated along fracture systems in the paleo-drainage areas.

'Chemical abrasion' U-Pb analysis of chondrules

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Acid leaching' is a proven method for removing non-radiogenic Pb from meteorites before U-Pb dating. However, side effects of acid leaching such as loss of radiodenic Pb, fractionation between U and radiogenic Pb, and possibly fractionation of radiogenic ^{207}Pb and ^{206}Pb compromise the quality of analysis and age interpretations. Acid leaching is known to induce similar complications in the U-Pb systems of zircon, but these problems can be circumvented by annealing zircons before acid leaching. Annealing restores crystallinity and 'seals' radiogenic Pb in zircon domains with moderately damaged crystal lattice, thereby suppressing U-Pb fractionation during leaching, but does not prevent dissolution of metamict zircon with disturbed U-Pb systems. Annealing together with subsequent acid leaching constitute 'chemical abrasion' [1] – one of the most efficient methods for obtaining accurate U-Pb ages of zircons.

We have applied similar treatment to U-Pb dating chondrules from the CV chondrite Allende. Although the concentration of U and Th in chondrules is too low to cause widespread radiation damage and metamicrization, the atoms of radiogenic Pb reside in alpha-recoil tracks with locally disturbed crystal lattice, and re-crystallizaion of these tracks can be expected to improve retention of radiogenic Pb, and to reduce U-Pb and ^{207}Pb-^{206}Pb fractionation.

Aliquots from a fraction of chondrule fragments were annealed at the temperatures between 600-900°C for 24 hours, and leached in dilute nitric and hot concentrated nitric and hydrochloric acids. Annealing did not cause detectable Pb loss. Retention of radiogenic Pb during leaching becomes stronger as the annealing temperature increases, but non-radiogenic Pb is retained more strongly as well. As the annealing temperature increases, the $^{206}Pb/^{204}Pb$ ratio in residues after acid leaching decreases from 100 for chondrules without annealing to 58, 31, 22 and 18.8 for the fractions annealed at 600, 700, 800 and 900°C, respectively. Annealed meteorite materials thus requite more intensive leaching for removal of non-radiogenic Pb. Isotopic analyses of these residues yielded a scattered Pb-Pb isochron corresponding to the age of 4568±10 Ma. The study of the effects of annealing on U-Pb concordance and ^{53}Mn-^{53}Cr and ^{26}Al-^{26}Mg systems is in progress.

[1] Mattinson (2005) *Chem. Geol.* **220**, 47–66.