# OAE's and the interdependence of P, N and trace metals

B. SAGEMAN, M. HURTGEN, D. ADAMS,
R. BARCLAY AND Y.J. JOO

Department of Earth and Planetary Science, Northwestern University, Evanston IL
(*correspondence: brad@earth.northwestern.edu)

Cretaceous ocean anoxic events, especially the early Aptian and Cenomanian-Turonian (C-T) events, are believed to reflect episodes of increased primary production leading to a global-scale enhancement of organic matter preservation; preservation is mainly attributed to intense oxygen depletion resulting from exceptional fluxes of organic matter. Three fundamental questions pervade the study of these events: 1) What initiated the heightened production? Did it include increase in average rates of production, a significant change in the total area of productive surface waters, or some combination of both? 2) What maintained elevated production levels for some 500 to 600 kyrs? and 3) What change in the biogeochemical system terminated these events? Given that productivity is thought to play the key role, our attention naturally turns to the biolimiting nutrients known to control primary production in modern oceans. These include reactive phosphorous, ultimately sourced by weathering of uplifted land masses or by recycling from anoxic sediments, reactive nitrogen, mainly sourced by bacterial transformations of $N_2$ and $NH_3$, and trace metals such as Fe, Mo, and Zn, which play critical enzymatic roles in the bacterial and algal communities that perform primary production and decomposition processes. Since the redox state of the marine realm exerts a strong influence on each of these systems, it stands to reason that they might be interdependent through the course of an ocean anoxic event. In this talk we collate observations drawn from a series of studies of the C-T OAE2 in order to develop an hypothesis about the linkage between P, N, and trace metals during OAE's. These studies include a stomatal index-based reconstruction of $pCO_2$ across the event, as well as a record of changes in reactive Fe and S isotopes from epieric and oceanic sites. The hypothesis states that OAE's are self-limiting because exceptional events of primary production lead to pervasive oxygen deficiency, which results in the eventual drawdown of redox-sensitive trace metals. Even if P regenerated from anoxic sediments finds a way to surface waters, N-limitation ultimately controls OAE duration when metal inventories reach some lower threshold.

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# Mineralogy, chemistry and distribution of mine tailings from the Murgul (Artvin) Cu deposit and their environmental impacts, NE Turkey

E.S. SAĞLAM*AND M. AKÇAY

Karadeniz Technical University, Department of Geological Engineering, 61080, Trabzon Turkey
(*correspondence: ssaglam@ktu.edu.tr)
(akcay@ktu.edu.tr)

Murgul Cu deposit is the largest copper mine of Turkey and is in production since pre-Republican era. Based on water and stream sediment sampling in 2005 (dry season) when the deposit was in regular operation and in 2006 when it was inactive or irregular in operation, this study aims at determining the impact of mine tailings disposed of into the streams draining the deposit.

Due to disposal of mine waste and tailings into the streams, particles originating from the Murgul mine are highly enriched in the alluvium. Stream sediment samples of 2005 period contain 4.33 - 50.87% Fe, 0.2 - 38.49% S, 9.2- 1926.6 ppm As, 210.4- 27439.6 ppm Ba, 0.8 - 23.2 ppm Cd, 272.1-9332.5 ppm Cu, 0.03 - 0.92 ppm Hg, 28.2- 682 ppm Pb, 2.4-2800 ppb Au and 196 - 3697 ppm Zn. In 2006 samples, however, the concentration of these elements show about 50% decrease.

The samples are divided into two groups based on the XRD analyses: Those collected from the areas of streams affected and unaffected by the waste and tailings disposal contain mainly quartz and pyrite, and quartz, illite, albite, chlorite and kaolinite, respectively. Quantitative analyses of the first group of samples indicate about 90% quartz and pyrite. Average pyrite contents of 2005 samples are much higher than 2006 samples in contrast to quartz content due to dilution at times of no-mine production. However, the second group of samples shows no mineralogical and compositional change with respect to the sampling period.

Tailings from the floatation discharge in 2005 period extend to large distances from the mine site, and concentrations of Fe, S, As, Ba, Cd, Cu, Hg, Pb and Zn increase with distance. This is in accord with the distribution of heavy metals in water samples. The concentrations of the same elements in 2006 samples, however, show a gradual decrease downstream from the discharge site.

Local colloidal ferrihydrite occurrences were observed about 8 km downsteam from the mine site due to heavy of suspended particles containing sulphides. They are in the form <2 cm thick shells covering the pebbles in the alluvium, and show that pyrite was oxidised resulting in acid mine drainage. However, pH values along the Murgul stream are neutral (pH= 7-8) which prevent the production of acid mine drainage despite the abundance of sulphides in the alluvium. The presence of ferrihydrite, on the other hand, is evidence to show that production of acidic pH in stream water, similar to those in the pits, is inevitable after the mine closure, unless measures are taken to prevent this.