

POSSIBLE ACID ROCK DRAINAGE EFFECT ON NEUTRAL pH

MÓRICZ, F.^{1*}, MÁDAI, F.¹ & WALDER, I.F.²

¹ Institute of Mineralogy and Geology, University of Miskolc, H-3515 Miskolc-Egyetemváros, Hungary

² Kjeøy Research & Education Center, Kjeøy, N-8412 Vestbygd, Norway

* E-mail: moriczferi@gmail.com

In the last two decades, the effect of Acid Rock Drainage (ARD) has become the leading environmental problem in metal mining. Weathering starts to degrade sulphidic type ore, which is unstable on the surface environment, resulting in low pH and mobilizing heavy metal contamination. The release of ARD to surface- and groundwater deteriorates the water quality and may cause depletion of alkalinity, acidification, bioaccumulation of metals, accumulation of metal in sediments, effects on habitats, elimination of sensitive species and unstable ecosystems.

Currently the handling, storage and monitoring of the abandoned mine sites, tailing and waste dumps are strongly regulated, which is a large step forward compared to the earlier sulphidic mining activity till the 90's. In case of mining activity the only short term environmental friendly thinking is not always exact because in the monitoring system the focus is on the first few years, or maximally a decade. However, the sulphide bearing material, in the first few years of the law regulated monitoring protocol, does not always show any acid producing activity and contamination, although the alteration of sulphide to sulphate are present. The occasion is that, the neutralizing minerals, such as calcite, dolomite or feldspars, can buffer the produced acidity, formed by the pyrite oxidation. In geology the sulphide oxidation is a normal process without serious pollution, because the amount of the sulphides, the water and the oxygen is limited in meaning of short term, compared to the huge amount of relative quickly exploited sulphide containing materials, produced by mining during years or decades. In the mining activity gives artificial environment, where the unit of the sulphide, mainly pyrite, oxidation exceeds the neutralizing or buffering capacity of the nature, thus causes ARD effect, which appears as acidic or strongly acidic seepage water, where the level of heavy metals concentration are elevated.

In September 2011, samples were collected from a waste dump, near Recsk, Hungary. The origin of the samples is the -900 level of the Western copper ore researching edit, number 3, which is in the contact of the exoskarn and the neighbouring carbonate rocks. This induced the high amount of the pyrite in the samples, which exceeds the 75 wt%, also more than 1 wt% of chalcopyrite, and pyrrotite and the few percentage of calcite. On the surface of the 20 cm sized samples from the material of the waste damp, some iron oxides have already appeared, which were mechanically removed in the step of the sample processing. Samples were crushed to 1 and 2 mm for the column test. During this geochemical analysis, the sulphide oxidation is sped up

to mimics of the long term behaviour of the mining material. In the present of water and oxygen, the pyrite starts oxidizing. The calcite, as quick neutralizing mineral, works well which is showed by the measured pH, between 7.1 and 7.2. Thus, the non acidic seepage lets the iron ions oxidize and form stable phases, which could continue until the pH goes under 4–4.5. Theoretically, the following stoichiometrically exact equation takes place, which is made by the combination of several equations of the ARD process: $2\text{FeS}_2(\text{s}) + 3\text{CaCO}_3(\text{s}) + 9\text{H}_2\text{O}(\text{l}) + 8\text{O}_2(\text{g}) \rightarrow 2\text{Fe}(\text{OH})_3(\text{s}) + 3\text{CaSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l}) + (\text{SO}_4)^{2-}(\text{aq}) + 3\text{CO}_2(\text{g})$.

Environmental problems will start, if the acid producing potential is higher than the neutralizing one, so beside the acidic environment, stable minerals cannot form and all the elements will be in dissolved phase, especially if the pH sinks under 1.5–2. In sample from Recsk, the amount of the pyrite is multiple higher than the calcite, thus environment pollution will take place in an uncertain time.

In this presentation the focus is on to prove the equation above, as well as to answer that thesis, whether there could happen oxidation in the zone of neutral pH. The proving process is to detect and measure the end members of part of the equation, thus the iron^{III}-hydroxide – which could be also iron oxides by dehydration, via phase of goethite – on the surface of the fresh pyrite grains, the gypsum coating on the surface of the calcite, detected by electron microprobe, the sulphate concentration in the seepage, measured by ion chromatograph and the carbon-dioxide gas in the air tightly closed sample keeper. As an evidence, the presence of iron containing minerals, gypsum, free sulphate ion and carbon dioxide proved that there is a sulphide oxidation. The low amount of calcite compared to that of pyrite determines ahead the environmental pollution in the future. The dropping amount of the calcite and the blocking of it by gypsum, justify the decreasing of the neutralizing capacity in the future, which will not be able to keep the balance, therefore the system will move toward acidic condition. The rate of oxidizing in the pyritic system increases exponentially, moreover it works as a chain reaction, thus moves itself ahead quicker and quicker. The ore mineralization is polymetallic, therefore copper, zinc, lead will also appear in the seepage, together with their replacement element, like cadmium or molybdenum.

With this presentation, the author would like to reflect on necessity of the circumspect handling and also on the accuracy planning in the storage system of the potentially dangerous waste and mine materials.