Acid- and base-neutralization capacity in mine water and brines

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Extended Abstract

Acidimetric and alkalimetric titration to the endpoint of pH 4.2 and 8.3 is commonly used in water chemistry to determine the amount of inorganic carbon species in water [1]. However, in mine water and brines the determination of inorganic carbon species should not be based on this method because buffering components such as polyvalent metals (e.g. iron, copper, manganese), non-carbonic acids (hydrogen sulfide, sulfuric acid, phosphoric acid, boric acid, silicic acid, organic acids, etc.), and the acid-base behavior of metals (aluminum, manganese, zinc, nickel, etc.) may be dominant and lead to completely wrong results with respect to the carbon species. As a kind of go around the hot peroxide acidity procedure is widely used for measuring the acidity of mine drainage. In this context, the poorly defined terms "net alkalinity" and "net acidity" are commonly used in particular in the mine-water community [2].

However, a better defined and more reliable approach is to determine the total inorganic carbon (TIC) by means of TIC analysis using NDIR (non-dispersive infrared) spectroscopy and then calculating the carbon species in the water based on the pH of the investigated water by using a thermodynamic speciation code like PHREEQC. Additionally, the acidimetric or alkalimetric titration curve provides hints on the buffer capacity of the water while the endpoint values are only of minor or no interest. The other elements can be determined by ion chromatography, ICP-MS or other modern technologies. Species distribution calculation will then be done with the help of chemical thermodynamic modeling, using e.g. PHREEQC, proving additional information such as saturation indices for certain minerals.

Two examples are presented: The first is the brine from the lithium-rich Salar der Uyuni, Bolivia, where boric acid dominates both alkalinity and acidity, which leads to completely wrong results for the carbon species if this is not considered. The second example presented is acid water from the pit mine lake Burghammer, Germany. For this water with a pH of 2.9 the titration curve and endpoints show that carbonic acid only plays a minor role for the buffer capacity of the water. Even after liming of the water to maintain neutral pH values, the alkalinity and acidity end-points do not reflect the carbonic acid species. They are overestimated by one order of magnitude by using the endpoints of titration in comparison to the TIC analysis readings.

Key words: alkalinity, acidity, silicate, borate, sulfide, metal, TIC, titration, thermodynamic model, PHREEQC

References

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