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Should a Humidity-Cell Sample Be Gently Agitated During Testing?

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Abstract

Should a humidity-cell sample be gently agitated during testing? In our experience, yes. We have found that gentle agitation of finer-grained humidity-cell samples each week minimizes the retention of geochemical reaction products. This is important for proper geochemical interpretations of bulk reaction rates, times to depletion, and carbonate molar ratios. In all cases, the humidity-cell closedown procedure, which includes the high-volume Final Flush, is necessary to test for geochemical retention and to include any retention in final interpretations.

1. Introduction

Under laboratory conditions, the periodic, thorough rinsing of crushed rock has been practiced for more than four decades (Hanna and Brant, 1962, using large-diameter glass cells). This kinetic test has become known as a "humidity cell", due to aeration with humid air at least part of each weekly cycle. The original procedure has been adapted for available materials like plastic boxes (Caruccio, 1968; Sobek et al., 1978) and plexiglass cylinders (Morin and Hutt, 1997 and 2001).

The fundamental objective of humidity cells has remained the same for decades: to obtain bulk reaction rates based on minimal retention of reaction products within the sample. It is important to note that trickle-leach columns and poorly flushed "cells" can retain reaction products, such as gypsum. Thus, these alternate tests lead to the underestimation of bulk reaction rates due to the retention, which has been incorrectly interpreted as humidity cells being "accelerated" (e.g., Benzaazoua et al., 2004). Therefore, an important part of the humidity-cell procedure is the efficient removal of weekly reaction products.

This leads to two important issues. How can the rinsing of weekly reaction products be maximized? How can the effectiveness of weekly rinsing be confirmed?

2. How can the rinsing of weekly reaction products be maximized?

Absolutely all weekly reaction products cannot normally be removed. For example, at near-neutral pH, much of the ferric iron from pyrite oxidation will likely be retained within the sample (Morin and Hutt, unpublished). In turn, this could retain some amounts of trace metals, although

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retention and subsequent underestimation of rates are not always the result (Ganor et al., 2005). Nevertheless, the objective is to maximize the rinsing of reaction products.

Excess water to saturate a sample is important for removing weekly reaction products. With a 200-g sample spread across the bottom of a plastic box, simply soaking in excess water for one hour was considered sufficient (Sobek et al., 1978). However, where a sample is piled within a cylinder, gentle agitation at least for finer-grained samples is recommended (Morin and Hutt, 1997 and 2001).

There is reticence by some to agitate cell samples (e.g., Lapakko and Antonson, 2006). This appears to reflect concerns over breaking down coarser particles and thus affecting test results. In our opinion, if gentle agitation breaks particles under laboratory conditions, then full-scale mining would lead to even more finer particles. As a result, testing of finer particles caused by gentle agitation would actually be preferred.

Does gentle agitation make much difference in weekly results? We have not tested both non-agitated and gently agitated samples at the same time, so we cannot provide a general opinion. However, one acidic tailings cell (pH ~2.5-3.0) was operated for 40 weeks, with instructions to gently agitate the cell sample each week. At Week 23, we discovered the laboratory was not agitating the sample, and agitation began. This resulted in a major increase in sulphate and acidity concentrations by more than one order of magnitude (Figure 1), and the recovered water (0.25 L) that week was roughly one-half of normal. Thus, a large portion of the non-agitated sample had not been flushed, although it was submerged with excess water each week for 23 weeks.

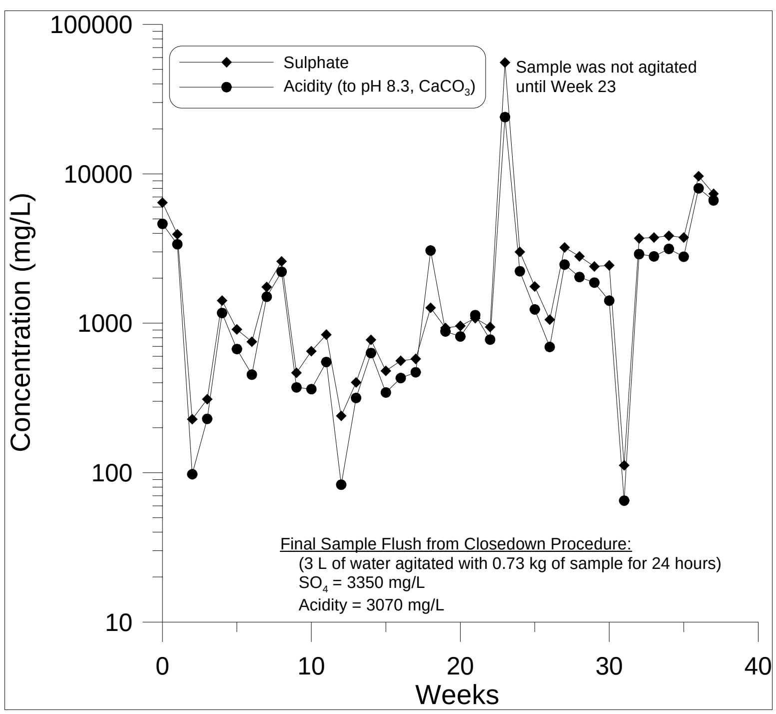

Figure 1. A Tailings Humidity Cell with Sample Agitation Started at Week 23, Showing a Large Release of Retained Sulphate and Acidity.

After a few weeks, sulphate and acidity returned to earlier levels that showed generally increasing trends (Figure 1). The return to earlier levels suggested most of the retained sulphate and acidity had been removed. Without agitation, the overall trend might have been the same, but the cumulative and average-weekly amounts of oxidation and acid generation would have been underestimated and the time to sulphide depletion overestimated.

3. How can the effectiveness of weekly rinsing be confirmed?

If the retention of reaction products is suspected during cell operation, the amount of weekly rinse water can be increased. Under a simple kinetic scenario with no retention, the addition of three times as much water each week should result in roughly one-third the aqueous concentrations on a mg/L basis. With retention, the aqueous concentrations will not decrease nearly as much, and thus the calculated bulk rate in mg/kg/wk will increase until the retained products are removed.

A formal check for retention is included in the humidity-cell closedown procedure (Morin and Hutt, 1997 and 2001) as a "Final Flush". The sample is agitated for 24 hours in excess water (3 L), and this water is then analyzed. Since weekly water addition to the sample in Figure 1 was 0.5 L/wk, the Final Flush concentrations in mg/L should have been roughly one-sixth the weekly concentrations, but were in fact higher. Thus, there was still retention of reaction products during testing, but it was not as substantial as the retention to Week 23.

4. Conclusion

In our experience, we find gentle agitation of finer-grained humidity-cell samples each week minimizes the retention of geochemical reaction products. This is important for proper geochemical interpretations of bulk reaction rates, times to depletion, and carbonate molar ratios. In all cases, the humidity-cell closedown procedure, which includes the high-volume Final Flush, is necessary to test for geochemical retention and to include any retention in final interpretations.

References

Benzaazoua, M., B. Bussière, A-M. Dagenais, and M. Archambault. 2004. Kinetic tests comparison and interpretation for prediction of the Joutel tailings acid generation potential. Environmental Geology, 46, p. 1086-1101.

Caruccio, F.T. 1968. An evaluation of factors affecting acid mine drainage production and the ground water interactions in selected areas of western Pennsylvania. IN: Proceedings of the Second Symposium on Coal Mine Drainage Research, p. 107-151. Bituminous Coal Research, Monroeville, PA, USA.

Ganor, J., J.E. Roueff, Y. Erel, and J.D. Blum. 2005. The dissolution kinetics of a granite and its minerals - Implications for comparison between laboratory and field dissolution rates.

Geochimica et Cosmochimica Acta, 69, p. 607–621.

Hanna, G.P., and R.A, Brant. 1962. Stratigraphic relations to acid mine water production. IN: Proceedings of the 17th Industrial Waste Conference, Series No. 112, Engineering Extension Series, Purdue University.

Lapakko, K.A., and D.A. Antonson. 2006. Pyrite oxidation rates from humidity cell testing of greenstone rock. IN: R.I. Barnhisel, ed., Proceedings of the 7th International Conference on Acid Rock Drainage (ICARD), p.1007-1025, March 26-30, 2006, St. Louis, MO, USA.

Morin, K.A., and N.M. Hutt. Unpublished. Ambiguities in scaling of ARD predictions from hand sample to full-size minesite component.

Morin, K.A., and N.M. Hutt. 2001. *Environmental Geochemistry of Minesite Drainage: Practical Theory and Case Studies - Digital Edition*. MDAG Publishing (www.mdag.com), Surrey, Canada. ISBN 0-9682039-1-4.

Morin, K.A., and N.M. Hutt. 1997. *Environmental Geochemistry of Minesite Drainage: Practical Theory and Case Studies*. MDAG Publishing (www.mdag.com), Surrey, Canada. ISBN 0-9682039-0-6.

Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. Report EPA-600/2-78-054, U.S. National Technical Information Report PB-280 495. 403 p.