



National Institute of Standards & Technology

Report of Investigation

Reference Material 8455

Pyrite Ore Bioleaching Substrate

This Reference Material (RM) 8455 was produced to provide a sample of mineral pyrite for use as a bioleaching substrate and for testing bioleaching rates. This RM is not certified but provides samples so investigators in different laboratories can be assured that they are investigating the same material. The material consists of 100 g of New Mexico pyrite.

The overall coordination of material preparation and technical measurements was performed by G.J. Olson, NIST Polymers Division.

The supporting aspects concerning the issuance of this Reference Material were coordinated through the Standard Reference Materials Program by J. S. Kane.

Mineralogical analysis was performed by the Department of Mining, Environmental and Geological Engineering of New Mexico Tech on polished specimens of the -10 mesh material.

X-ray diffraction was performed by S. Krueger, NIST Polymer Division.

A detailed account of preparation and characterization of the material is given in reference 1.

Material Preparation

The pyrite (20 kg, -10 mesh) was obtained from the Waldo Mine, New Mexico through the Department of Mining, Environmental and Geological Engineering, New Mexico Tech, Socorro, New Mexico. The material was washed twice in 4.6 M HCl, rinsed extensively with deoxygenated distilled water and dried under nitrogen at 60 °C. The washed material was ground in a ceramic ball mill, and a -165, +250 mesh fraction was obtained, mixed, and dispensed (100 g quantities) into glass bottles. The bottles were heated in a vacuum oven at 125 °C for 1.5 hr. After cooling, the oven was brought to atmospheric pressure with high purity nitrogen, the bottle caps were tightened, and the bottles vacuum-sealed in foil pouches.

Recommended Procedures for Storage and Use

Reference Material 8455 should be kept at room temperature in its original bottle, tightly capped, preferably in a vacuum desiccator under an inert atmosphere. If the material is to be used for microbiological procedures, samples should be removed aseptically.

Gaithersburg, MD 20899
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William P. Reed, Chief
Standard Reference Materials Program

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Composition

The as-received material was 95-96% pyrite, 3.5-4.0% specular hematite (occurring as blades within the pyrite and as intergrowths with scant magnetite) and <0.5% chalcopyrite (occurring as inclusions within pyrite or scant sphalerite). Traces of magnetite, sphalerite and galena were present. Small amounts of SiO₂ (quartz) were also detected by x-ray diffraction. There was no evidence of the presence of marcasite. Chemical analysis of single samples from three different bottles showed that the material contained 47.0% Fe (standard deviation 0.94%) and 49.6% S (standard deviation 2.13%).

Bioleaching Rate

The rate of bioleaching of Fe from the pyrite material by *Thiobacillus ferrooxidans* (American Type Culture Collection strain 13661, reisolated on ferrous iron agar) was determined by a number of cooperating laboratories using a new ASTM method (ASTM Committee E-48, Standard Test Method for Determining the Rate of Bioleaching of Iron From Pyrite by *Thiobacillus ferrooxidans*). Results of the determinations are shown in Table 1. Rates from each laboratory are means of at least three flasks, and were not corrected for Fe removed by sampling.

Table 1

Rate of bioleaching (mg Fe per liter per hour)

Laboratory	Rate	% r.s.d.
1	8.8	19
2	7.8	14
3	17.1	6
4	10.0	4
5	17.8	11
6	15.6	9
7	13.2	26
8	9.1	4
mean	= 12.4	
standard deviation	= 4.0	
% relative s.d.	= 32	

The rate of abiotic leaching of Fe (sterile controls) was determined to be 0.36 mg Fe/l/hour (mean of results from 4 laboratories).

Participating scientists and laboratories (not necessarily listed in order above): H.L. Ehrlich, Rensselaer Polytechnic Institute, Troy, NY; P. Greg McMillen, Tonkin Springs Gold Mining Company, Elko, NV; E. Baglin, U.S. Bureau of Mines, Reno, NV; J.A. Brierley, Newmont Metallurgical Services, Inc., Salt Lake City, UT; G. Olson, NIST; A.E. Torma, New Mexico Tech, Socorro, NM; F. Baldi, University of Siena, Italy; G. Rossi, University of Cagliari, Italy.

References

1. G.J. Olson, "Development of Ore Bioleaching Standards," in Proc. Internat. Symp. Biohydrometallurgy, Jackson, Wyoming, August 1989, pp. 71-79. Editors: J. Salley, R.G.L. McCready, P.L. Wichlacz; CANMET SP89-10, Canada Centre for Mineral and Energy Technology, Ottawa.
2. American Society for Testing and Materials, "Standard Test Method for Determining the Rate of Bioleaching of Iron From Pyrite by *Thiobacillus ferrooxidans*," Designation E 1357-90, in Annual Book of ASTM Standards, ASTM, Philadelphia, PA 1990.