Redox reaction of pyrite with Se

FABRIZIO BARDELLI[1]*, MINGLIANG KANG[1,2],
ANTOINE GEHIN[1] AND LAURENT CHARLET[1]

[1]ISTerre, Maison de Geosciences, 38041 Grenoble, France
(*correspondence: fabrizio.bardelli@gmail.com)
[2]Chinese Academy of Sciences, Guangzhou, 510640, China

The radioactive isotope ^{79}Se with a half-life of 2.95×10^5 years, is presently considered as the key mobile fission product for the disposal of spent fuel and high-level radioactive waste [1]. Its solubility largely depends on redox conditions: Se(IV) and Se(VI) prevail as very mobile aqueous oxyanions, while the oxidation states 0, -I, and -II are solids with low solubility [2]. Due to the weak adsorption of Se(IV) and Se(VI) on natural minerals, and in particular on granite or claystone minerals, chemical reduction is considered to be the most effective way to immobilize ^{79}Se.

On the other hand, pyrite (FeS_2) is the most frequent sulfide mineral and is also present in geological barriers of nuclear waste repositories [3]. Its strong reducing capacity and its stability under anoxic condition make it a good candidate for the immobilization of redox-sensitive radionuclides, like ^{79}Se. Many works have focused on the identification of the reduced form of selenium when reacted with pyrite, but reported conflicting results [4,5,6]. Therefore we report a systematic where we investigate the effects of the reaction of Se(IV) and Se(VI) with pyrite in several different experimental conditions.

Experiments where conducted at ph 5.05, 5.65, 6.1, 7.0, and 8.5, reaction times of 7, 24, 36, and 48 days, and, at pH 7.0 and 8.5, with and without the addition of extra Fe^{2+} (10^{-4} mol/l). ICP-OES measurements where used to monitor the iron and Se concentrations and showed a decreasing trend of Se and increasing iron as a function of time. XAFS spectroscopy was used to unravel the selenium speciation. At pH 5.05 and 5.65 Se(0) was found to be the main reaction product, while at pH > 5.65, in addition to Se(0), XANES suggested the formation of iron selenides (Se -I or –II), in an amount which increased with the reaction time. The presence of iron selenides is further supported by Mössbauer spectroscopy clearly showing two different environments for Fe^{2+} in pyrite reacted with Se.

The results carried out in this study suggest that pyrite can significantly attenuate the mobility of ^{79}Se through chemical reduction.

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Analysis of methanogen communities

LARRY BARESI

California State University, Northridge, CA 91330 USA
(correspondence: larry.baresi@csun.edu)

Methanogens are an exciting group of microorganisms that live under conditions that are of interest to many engineers. They have been found to be active in coals, shales, and other carbon rich environments acting as both the final hydrogen and carbon sink producing methane as the final product. Physiological, molecular biology, biochemical, genetic, and ecological studies of these organisms can play a key role in optimizing their use. I will discuss the role of both past and present techniques such as DGGE/TGGE, 16s sequencing, bioinformatics, and metagenomics in expanding our understanding of this group and their associated organisms. I will also discuss how these new advances in our knowledge base can be used for the development of more effective biodegradation processes.