Arsenic association with iron-based colloids in historic gold mine tailings

KATHRYN J. TINDALE[1], PRITESH J. PATEL[2] AND DIRK WALLSCHLÄGER[3*]

[1]Trent University, Peterborough, Canada, kathryntindale@trentu.ca
[2] Trent University, Peterborough, Canada, priteshpatel@trentu.ca
[3] Trent University, Peterborough, Canada, dwallsch@trentu.ca
(* presenting author)

Background

Historic gold mining activities in Nova Scotia, Canada, have left behind large amounts of spent and weathered tailings material that usually contains very high arsenic concentrations. Several of the larger abandoned mining sites are in proximity of residential areas, raising potential concerns about arsenic export off-site via surface and/or ground water flow. Previous studies have found elevated arsenic concentrations in surface, pore and ground waters at the sites. Since physical and chemical speciation have significant impacts on arsenic mobility and toxicity, we investigated if colloidal arsenic species existed in the waters at these sites.

Methods

64 surface water, ground water and pore water samples were collected at three locations within two abandoned gold mine sites in Nova Scotia in May 2011. Samples were analyzed for colloidal arsenic, as well as other colloidal constituents, by asymmetric flow-field flow fractionation-inductively-coupled plasma-mass spectrometry (FFF-ICP-MS), for dissolved arsenic species by anion-exchange chromatography-ICP-MS, and for total dissolved arsenic by ICP-MS.

Results

Colloidal arsenic fractions were encountered only in a small number of the collected samples. In those samples, colloidal arsenic constituted < 20 % of the total dissolved arsenic. Most of the colloidal arsenic was associated with iron-based mineral particles of 6 – 9 nm mean diameter. Based on the iron/arsenic ratio of these colloids, they appeared to be either discrete iron-arsenic minerals like scorodite, or iron (oxy)hydroxide with adsorbed arsenate. In one sample, we also obtained some tentative evidence of arsenic being associated with very small (< 2 nm mean diameter) organic matter-based colloids, which also contained iron and manganese.

To our knowledge, this is one of the first reports of the existence of colloidal arsenic in ambient samples. At the studied sites, colloidal arsenic was only an infrequent and minor component of the total dissolved arsenic concentration during the conducted sampling campaign, and therefore probably not very important for the overall transport and toxicity of arsenic in these systems.

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The Study of the Sequence Stratigraphy and the Sedimentary Enviroment of Ordovician in Southern Margin of Sichuan Basin

YANG WEI[1] ,ZHANG TINGSHAN[2*],LIU ZHICHENG[3] , AND MIN HUAJUN[4]

[1]State key laboratory of oil and reservoir geology and exploitation,Chengdu, China
rexswpu@163.com
[2] State key laboratory of oil and reservoir geology and exploitation,Chengdu, China
zts_3@126.com (* presenting Author)
[3] State Key Lab.of Oil&Gas Reservoir G&E Engineering,Chengdu, China,
rex_swpu2005@126.com
[4] State Key Lab.of Oil&Gas Reservoir G&E Engineering,Chengdu, China
minesky@126.com

Southern margin of Sichuan Basin contains well developed Ordovician, which carbonate rocks in this area are well developed and widely distributed except for the Wufeng Formation in upper Ordovician and the Meitan Formation in lower Ordovician, those are clastic deposition. According to the data analysis of outcrop and bore hole in the study area, the sequence stratigraphic framework of Ordovician was established using the application of theories in carbonate sequence stratigraphy, combined with petrology, paleontology, the characteristics of carbon and oxygen isotopic, six third-order sequences were developed from the Lower Ordovician to the Upper Ordovician, and each sequence can be subdivided into transgression systems tract (TST) and high systems tract (HST),but be lack of the lowstand system tract(LST) because the study area of Ordovician was mainly located on a carbonate platform. On this basis, it is shown that the broadly open sea shelf type with flat floor and the platform sediment model are well developed in the study area of Ordovician. There were two large scale sea-level rise in the Ningguo period of the Lower Ordovician and Wufeng period of the Upper Ordovician between Linxiang period. Under the effect of sea-level changes, the carbonate platform was rapid coverd by the accumulation of siliciclastic. During the period the western Yangtze plate developed a wide sea shelf and shale deposited, which occurred carbonate platform drowning incidents. The results reveal that the carbon and oxygen isotopic migration are consistent with the process of environment changes. Sea level changes were the principal factor that controlled the development of Ordovician depositional system in southern margin of Sichuan Basin of Ordovician. It is found that the carbon and oxygen isotopic change in the grain size sediment is not only closed to the sea-level changes, but better identify to the condensed section, sequence boundaries et al, which can be used as a reliable secondary sign to determine the sequence stratigraphy division and the depositional environment.

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