ASSESSMENT OF WATER QUALITY IN A WATERSHED IMPACTED BY NATURAL ARD USING MINERALOGY AND REMOTE SENSING

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Extended Abstract

In many areas of the Western U.S. containing mineralization that includes large sulfide bodies, natural acid rock drainage (ARD) from sulfidic alteration adversely affects the water quality of the host watershed. This occurs regardless of whether any mining has occurred in the watershed, but mining activity can exacerbate ARD production. The Colorado Geological Survey and a team of remote sensing experts from industry are conducting a National Aeronautics and Space Administration (NASA) -funded study of the ARD impacted Lake Creek watershed in the upper Arkansas River basin of Colorado (Fig. 1) using remote sensing technology to characterize, map, and monitor water quality in such watersheds.

Hyperspectral remote sensing technology is used to identify the mineralogy of the stream precipitates, which form the connection between pH, the type of ARD present and subsequent water quality. The mineralogy of these metal precipitates is directly determined by the stream water chemistry. Thus, remote sensing can indirectly assess water quality by linking the precipitate mineralogy to the water chemistry necessary for its formation. Water chemistry and streamflow data provide a detailed picture of metals transport and solubility in the watershed (Bird et al., 2003). Oxidizing, hydrothermally derived alteration and sulfide minerals are the source of the ARD. Secondary iron sulfates, iron oxides and oxyhydroxides, and aluminum hydroxides precipitate from the acidic stream waters in distinct pH zones. This is a function of dilution (i.e., changing pH conditions) by mixing with less acidic to neutral tributaries downstream from the

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ARD sources (Fig. 2). Image maps of mineralogy from the remote sensing data show a distinct correlation between the precipitates and water quality and can be used to predict and map the extent of ARD impacts.

These findings are relevant to streamlining statewide water quality assessments and potential reclamation efforts. Ultimately, the objective is to be able to identify the relative contributions of natural and anthropogenic sources of acidity and metals contamination to impacted drainages.

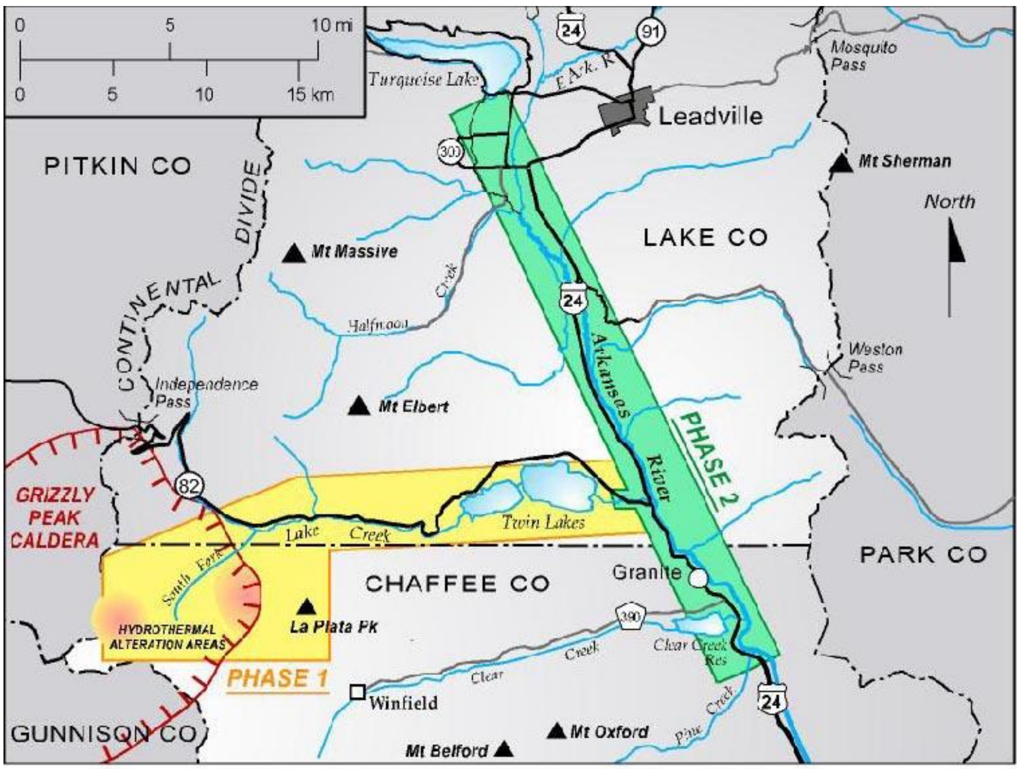

Figure 1. Location map for ARD project study area in central Colorado. The Phase 1 drainage basin has been impacted by ARD from natural sources. The Phase 2 drainage has been impacted dominantly by tailings and ARD from the Leadville mining district and other mining areas to the west and northwest of Leadville.

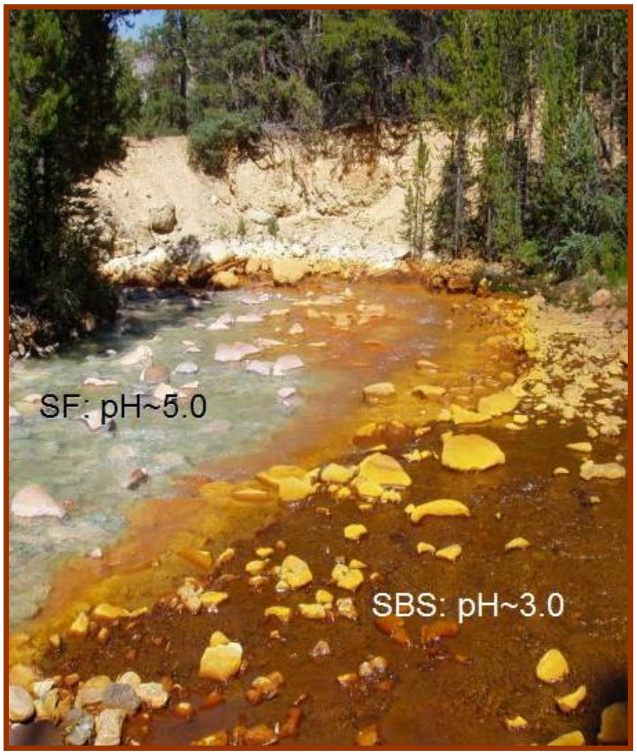

Figure 2. View of chemistry in action during low flow (August 14, 2003) at the confluence of two ARD impacted streams (South Fork of Lake Creek on left and Sayres Bowl Stream (SBS) on right) in the Phase 1 study area.

The South Fork here has a pH of about 5 and is precipitating predominantly white aluminum oxyhydroxides. The SBS proximally drains one of the source areas for ARD, has a pH of about 3, and has a very high iron load, in addition to dissolved aluminum, as evidenced by the multicolored iron sulfates (coatings and ferricrete) precipitated near the confluence. Where the two waters mix, a sharp zonation between pH zones occurs and results in distinct mineralogy (aluminum oxyhydroxides, iron oxyhydroxides, and iron sulfates) for each zone. At and downstream of such confluences, metals drop out of solution rapidly as pH changes, although metal loads persist all the way down this drainage to Twin Lakes Reservoir. More detail on the water chemistry of Lake Creek is provided in Bird et al. (2003).

Acknowledgements

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Literature Cited

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