Prepared in Cooperation with the U.S. Environmental Protection Agency

Presentation Showing Results of a Hydrogeochemical Investigation of the Standard Mine Vicinity, Upper Elk Creek Basin, Colorado

Open-File Report 2008–1012

U.S. Department of the Interior
U.S. Geological Survey

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By Andrew H. Manning, Philip L. Verplanck, M. Alisa Mast, and Richard B. Wanty

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Preface

This Open-File Report consists of a presentation given in Crested Butte, Colorado on December 13, 2007 to the Standard Mine Advisory Group. The presentation was paired with another presentation given by the Colorado Division of Reclamation, Mining, and Safety on the physical features and geology of the Standard Mine. The presentation in this Open-File Report summarizes the results and conclusions of a hydrogeochemical investigation of the Standard Mine performed by the U.S. Geological Survey (Manning and others, in press). The purpose of the investigation was to aid the U.S. Environmental Protection Agency in evaluating remediation options for the Standard Mine site. Additional details and supporting data related to the information in this presentation can be found in Manning and others (in press).

Reference Cited

Manning, A.H., Verplanck, P.L., Mast, M.A., and Wanty, R.B., in press, Hydrogeochemical investigation of the Standard Mine vicinity, upper Elk Creek Basin, Colorado: U.S. Geological Survey Scientific Investigations Report 2007-5265.

Hydrogeochemical Investigation of the Standard Mine Vicinity, Upper Elk Creek Basin, Colorado

Andrew Manning, Philip Verplanck, Alisa Mast, and Richard Wanty

U.S. Geological Survey, Denver, CO

U.S. Department of the Interior
U.S. Geological Survey

USGS
science for a changing world

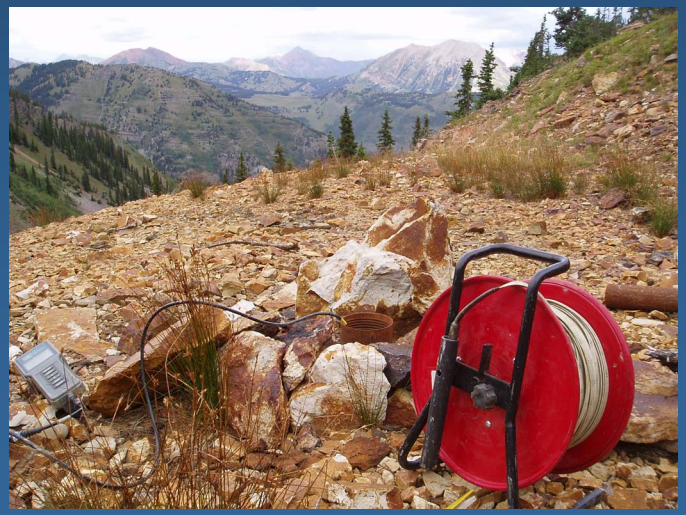
Background on USGS

• One of the missions of the USGS is to provide unbiased science information on natural resources to assist decision makers

• USGS has been working on water and mining resource issues for over 125 years

• USGS has been working in the Elk Mtns. for a long time:

- Operated stream gages since 1905
- Made several geologic 1:24,000 scale maps
- Completed mineral assessments
- Performed environmental geochemistry studies in Mt. Emmons area, focusing on Redwell Basin



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Study Objectives

Characterize groundwater flow system:

- Where does ground-water flow occur?
- What are geological controls on flow?
- How does ground-water flow to and through the Standard Mine?
- What are characteristic ground-water residence times?

Characterize ground-water chemistry:

- How do metal concentrations in mine discharge compare to concentrations elsewhere in basin?
- What is the main source of the high metal concentrations?
- How do metal concentrations in mine discharge vary with time?

Characterize surface-water chemistry:

- How do metal concentrations in Elk Creek vary with time?
- What is the source of high metal concentrations in Elk Creek?

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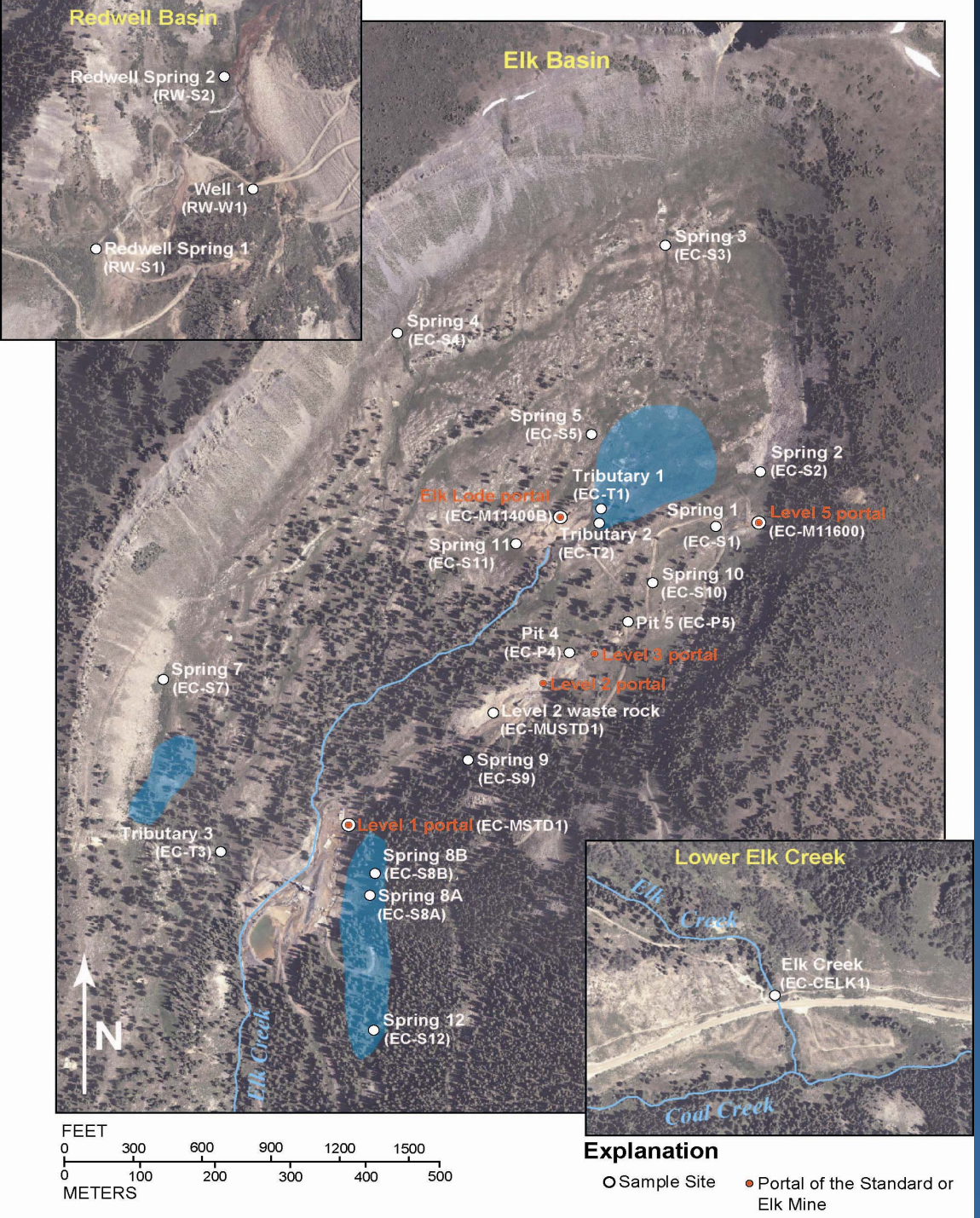

Methods

- Ground- and surface-water samples collected from summer 2006 through spring 2007
  - One-time sampling of above-ground sites in August 2007
  - One-time sampling of underground sites in the Standard mine in August 2007
  - Time-series sampling from summer 2006 through spring 2007 at the Standard Mine portal and Elk Creek

- Samples collected from springs, mine tunnel discharge, waste-rock pile discharge, exploration pits, underground workings of Standard Mine, and Elk Creek

- Samples were analyzed for:
  - Major ions and trace elements
  - Multiple isotopes
  - Tritium and dissolved gases

Results

Ground-Water Flow

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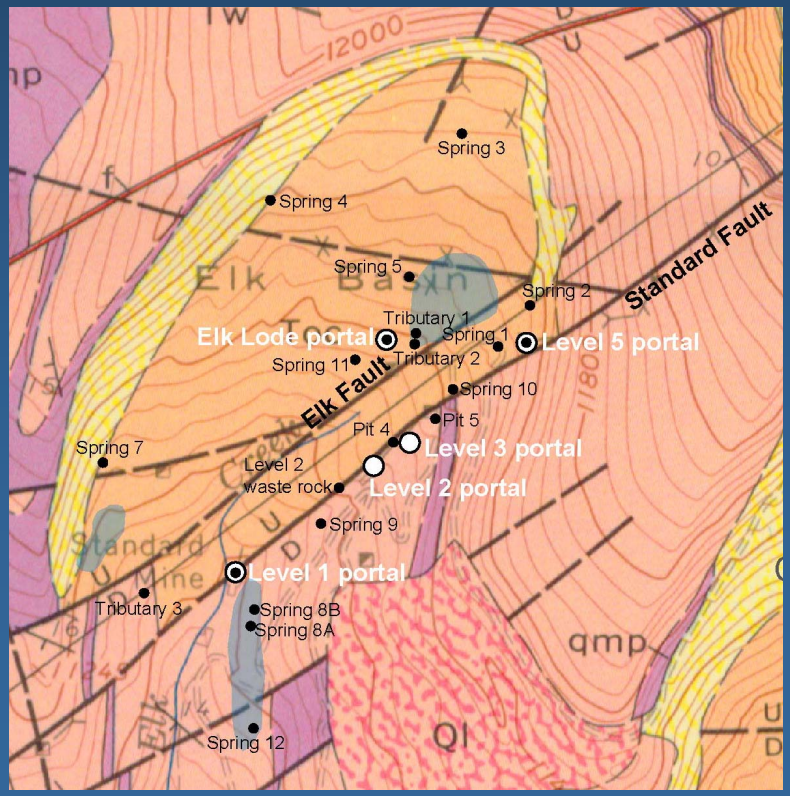
Controls on Shallow Ground-Water Flow

Simple topography, not geology, appears to mainly control shallow ground-water flow

- Spring locations not correlated with map-scale faults
- Springs locations not correlated with geologic units
- Springs occur on basin floor



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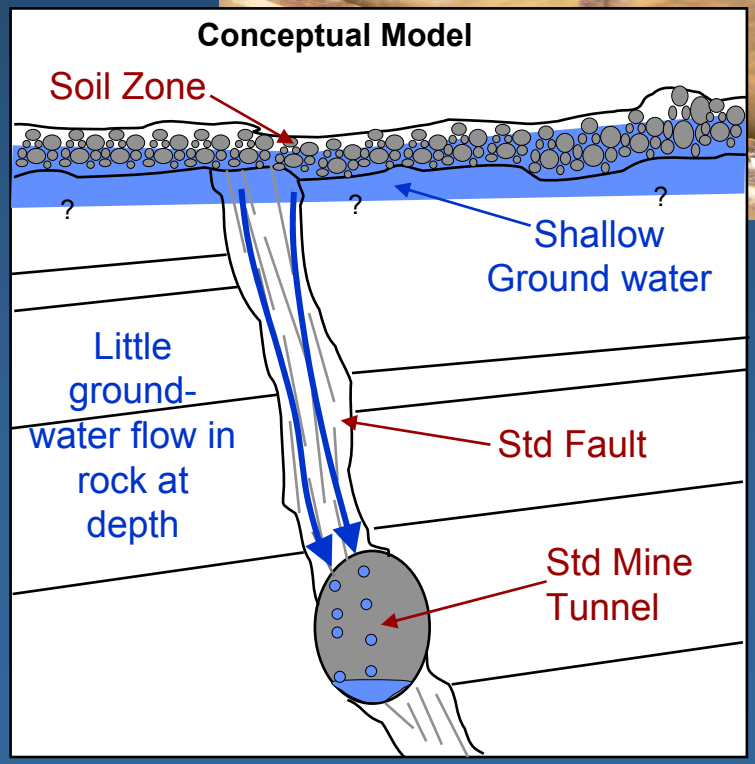
Ground-Water Flow to Standard Mine

Standard Fault itself probably main pathway of ground-water flow from shallow subsurface to the mine workings at depth

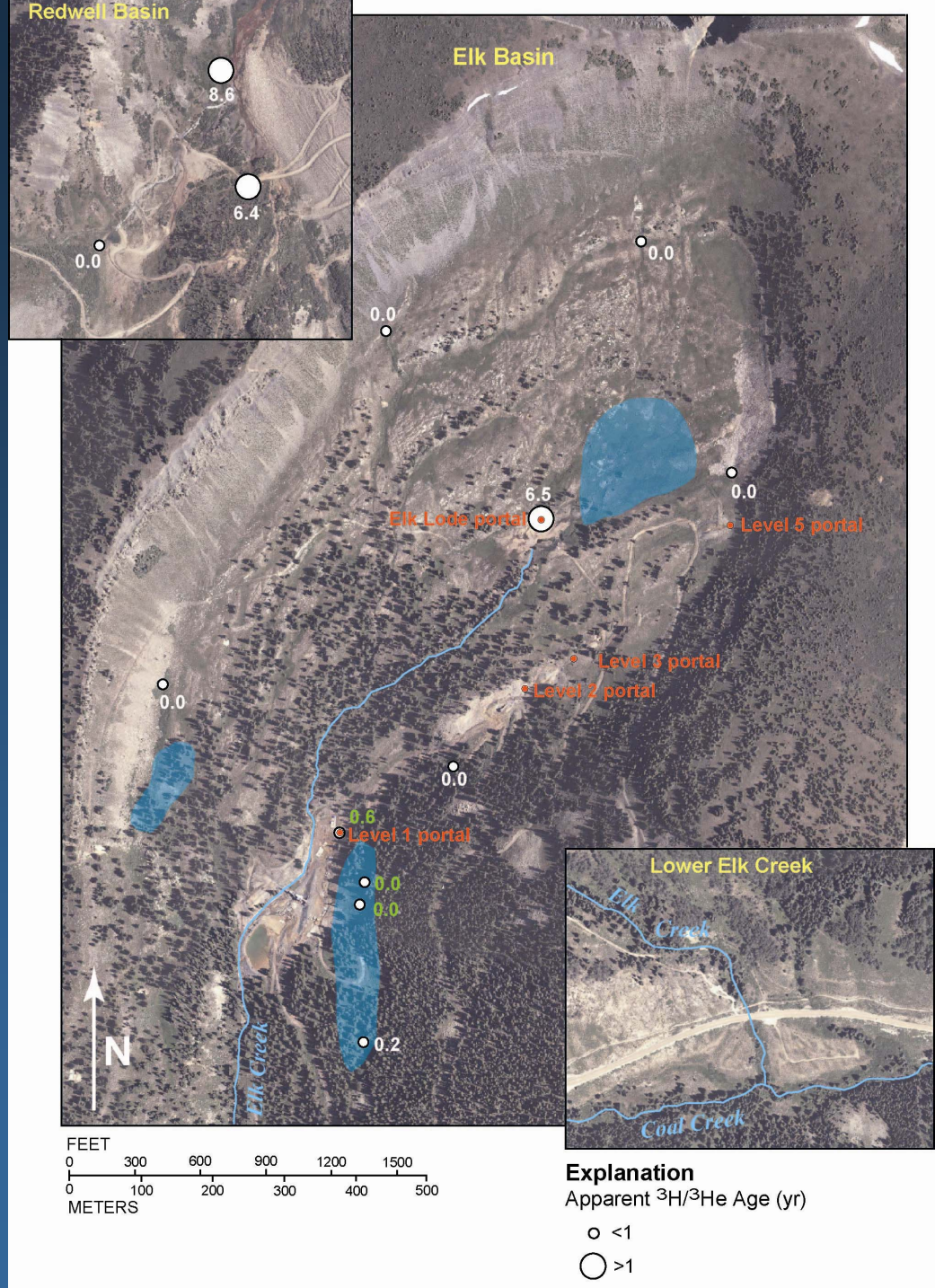
- Discrete inflows from cross-faults or other geologic features not observed
- Water enters Levels 3 and 5 as persistent dripping from standard fault zone material



Age of Shallow Ground Water

Shallow ground water in Upper Elk Creek Basin very young - dominantly weeks to months old rather than years old

- Tritium/helium-3 ground-water ages dominantly less than 1 year
- Tritium concentrations show effects of seasonal variations in precipitation tritium concentrations



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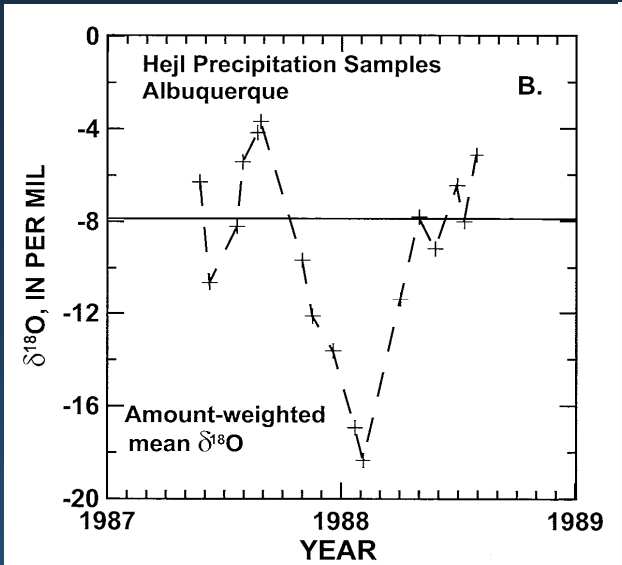
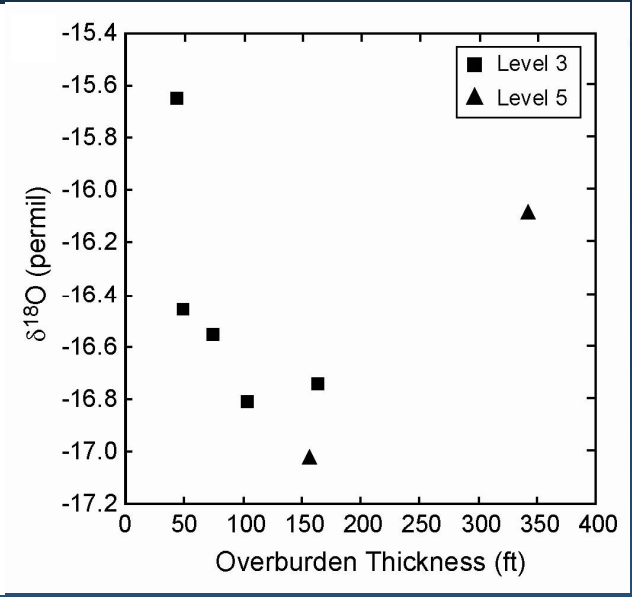
Age of Standard Mine Water

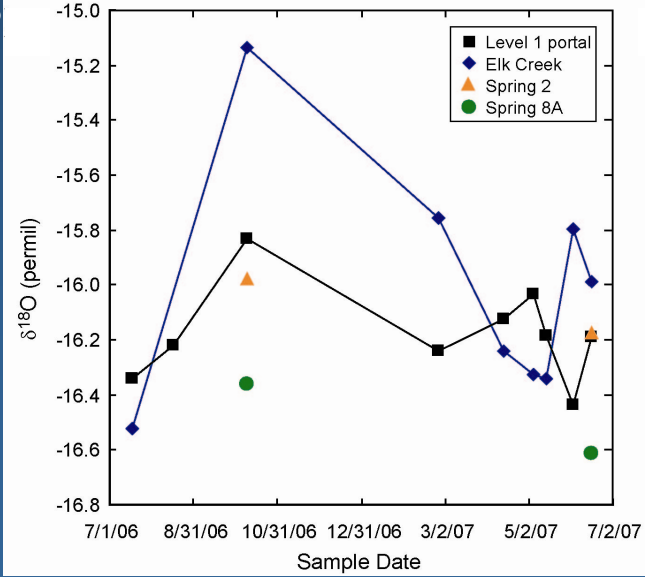
Ground water entering and discharging from the Standard Mine also largely less than 1 year old

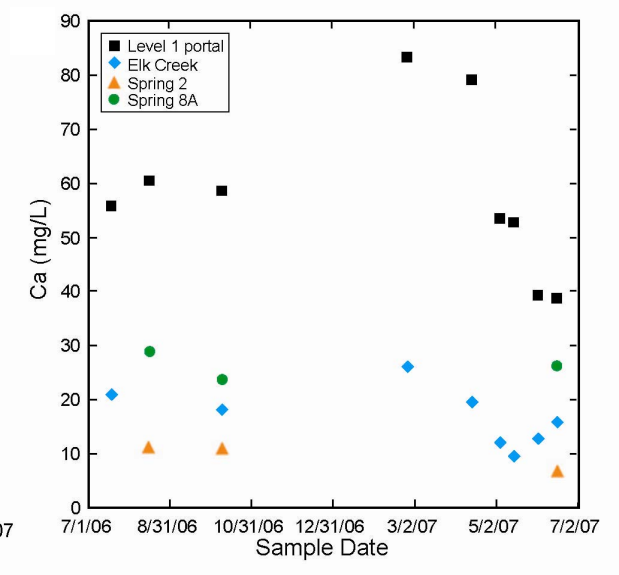
- Two tritium/helium-3 ground-water ages less than 1 year
- Stable isotopes and tritium concentrations underground show effects of seasonal variations in precipitation
- Stable isotopes and chemistry of Level 1 discharge show large seasonal variations
- Young age inconsistent with large mine pool



(From Plummer and others, 2004)







Plummer, L.N., Bexfield, L.M., Anderholm, S.K., Sanford, W.E., and Busenberg, E., 2004, Geochemical characterization of ground-water flow in the Santa Fe Group aquifer system, Middle Rio Grande Basin, New Mexico: U.S. Geological Survey Water Resources Investigations Report 03–4131, 395 p.

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Findings:
Ground-Water Chemistry

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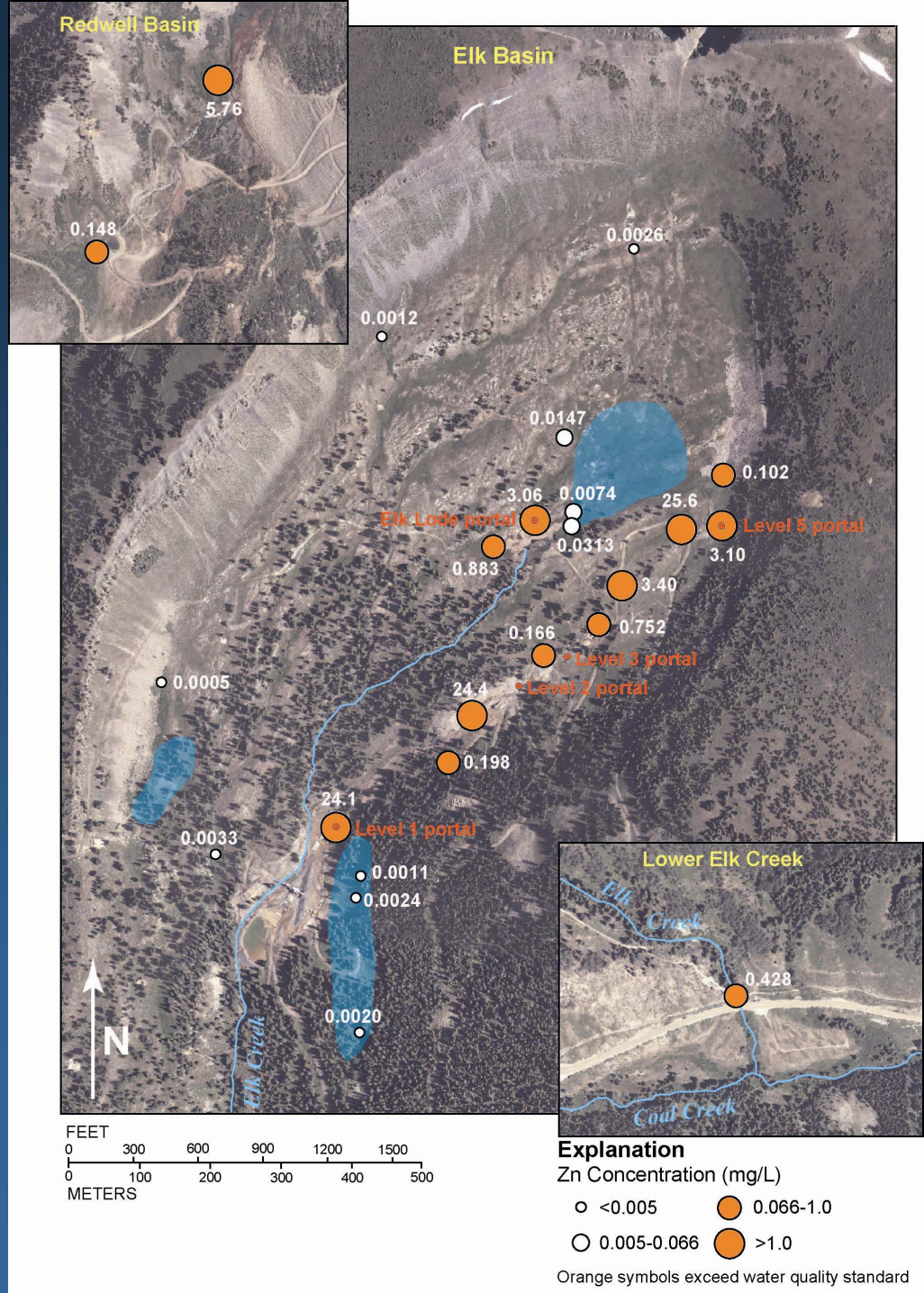
Controls on Ground-Water Metal Concentrations

Presence of sulfide-rich mineralized rock primary control

- Metal concentrations consistently elevated within or immediately down-gradient of areas where sulfides abundant
- Metal concentrations in Level 1 discharge among highest measured in Elk Basin



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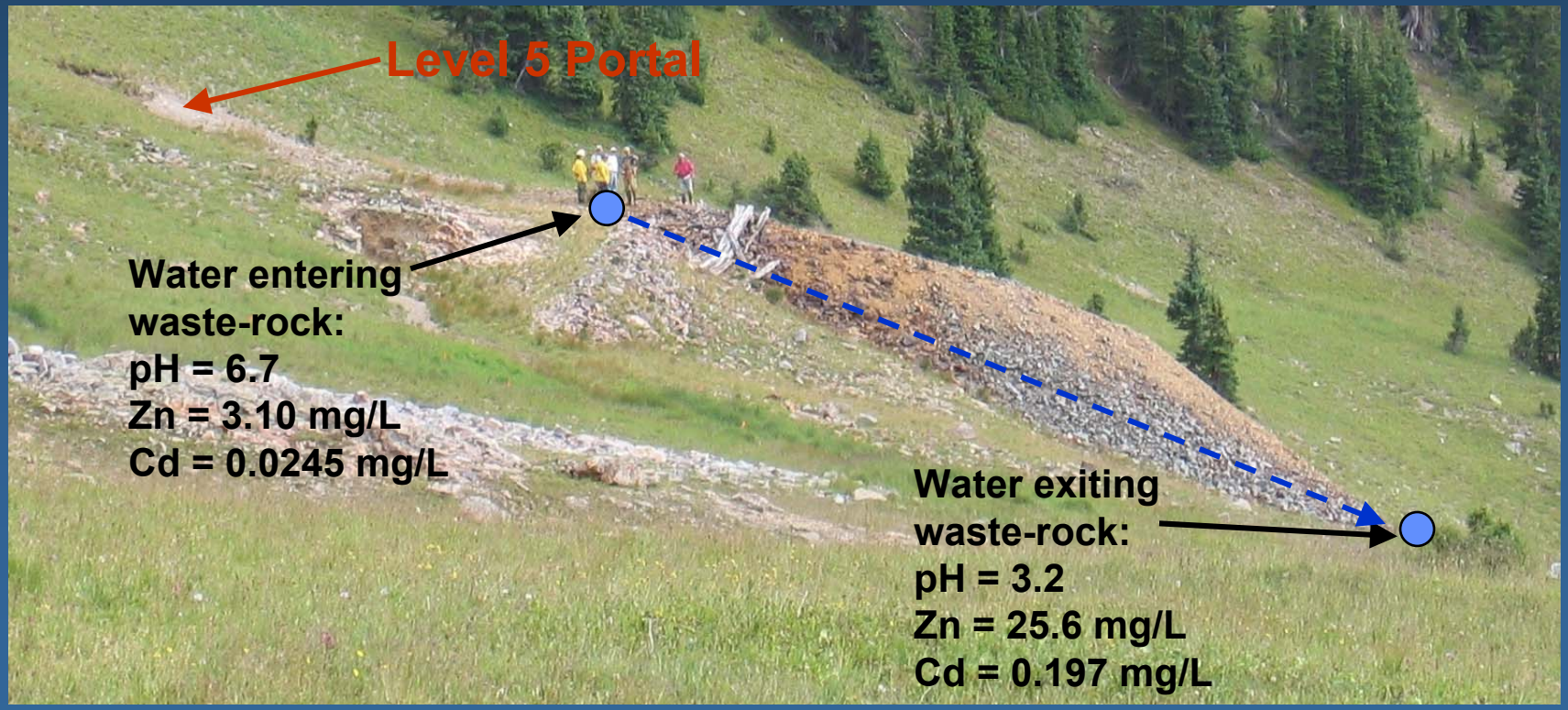
Controls on Ground-Water Metal Concentrations

Waste-rock piles can further elevate metal concentrations

- Highest metal concentrations typically observed in ground water discharging from waste-rock piles
- Water discharging from waste-rock had higher metal concentrations than water infiltrating waste-rock



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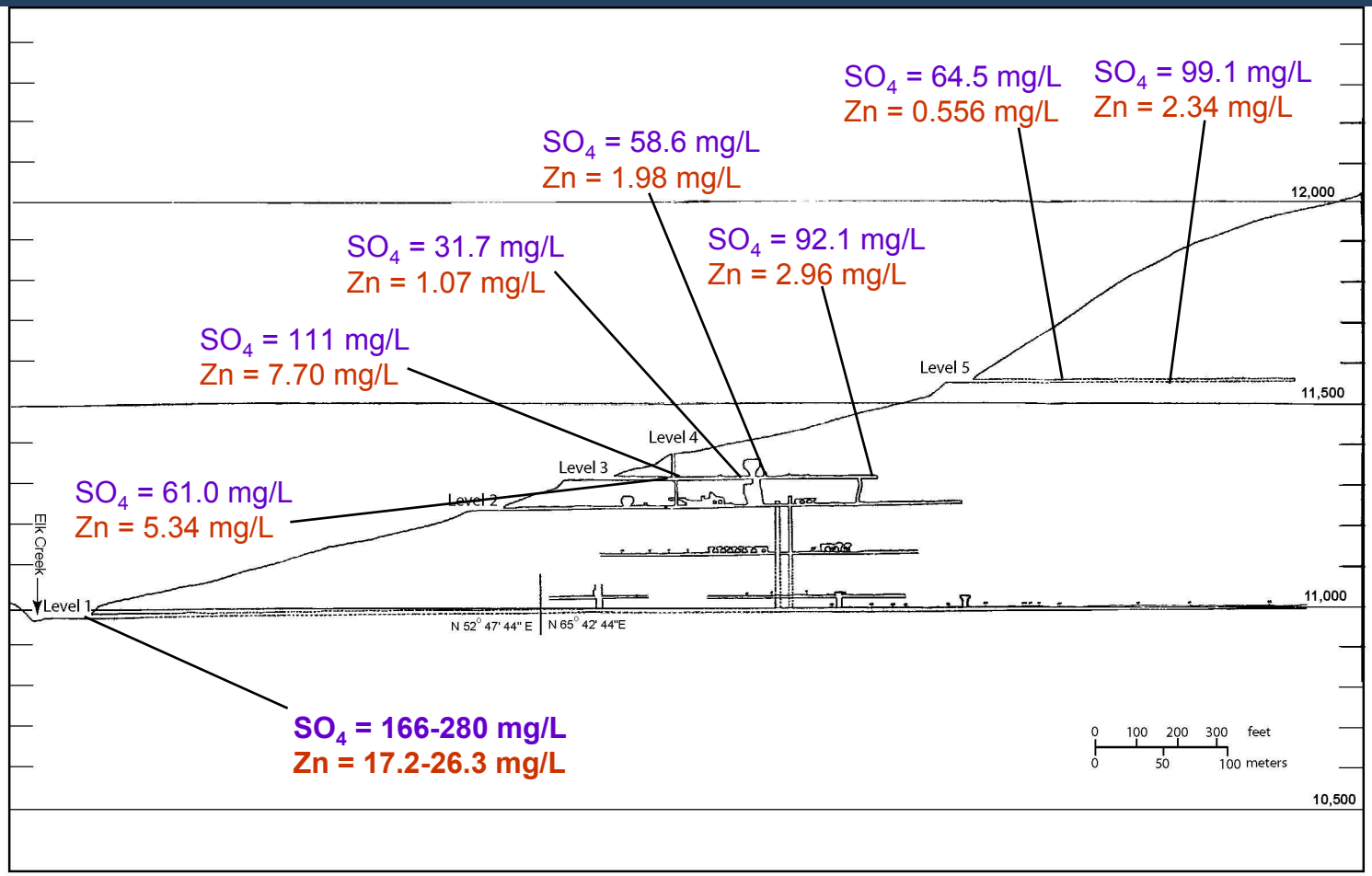
Source of Elevated Metal Concentrations In Level 1 Discharge

Primary source of elevated metal concentrations in Level 1 discharge water was not found

- Concentrations of many chemical constituents along with strontium isotope data indicate that sampled waters cannot be the source of metals in Level 1 discharge



Redwell Basin
SO_4 < 81.5mg/L
Zn < 5.76 mg/L

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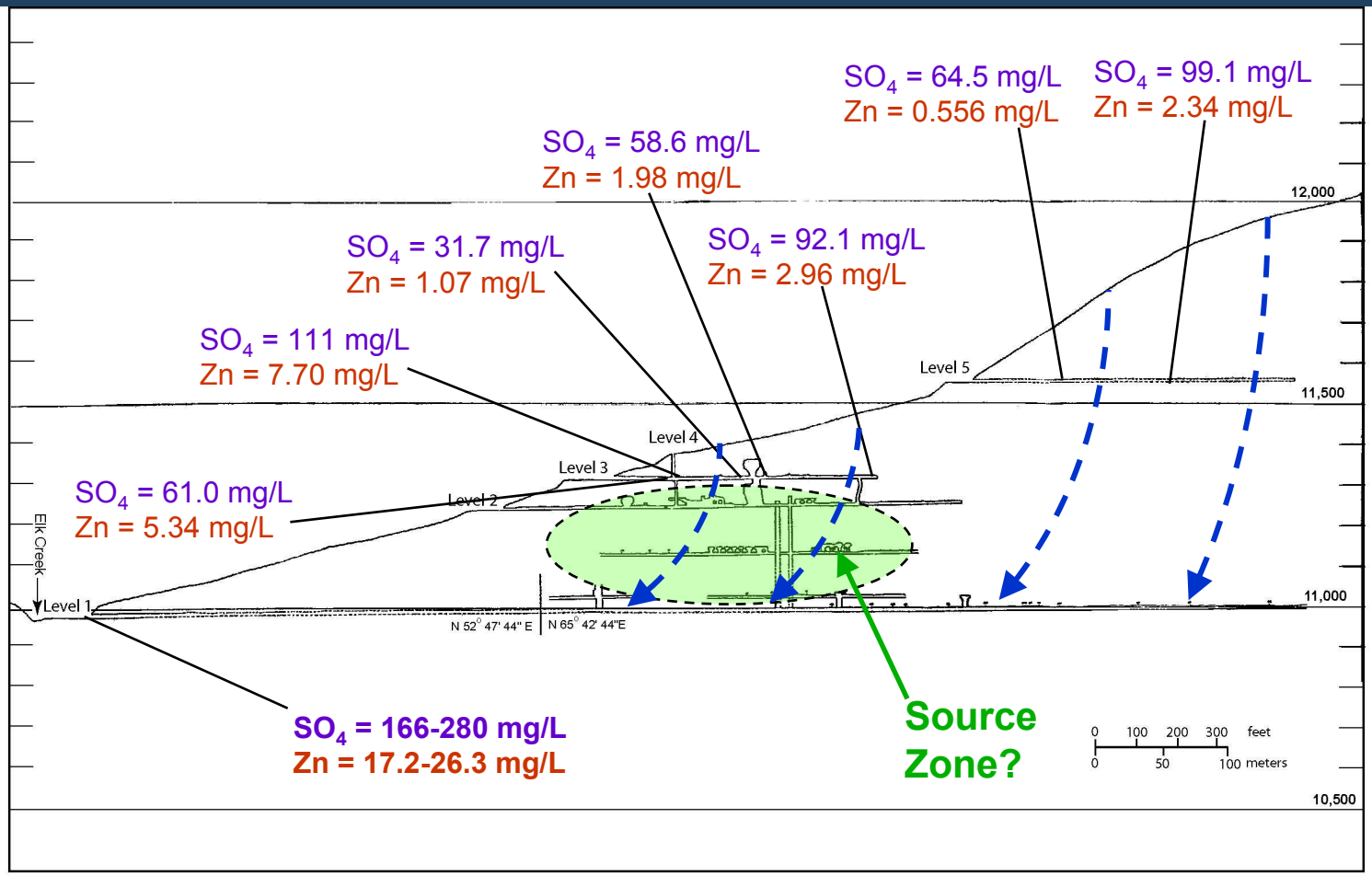

Redwell Basin
SO_4 < 81.5mg/L
Zn < 5.76 mg/L

Findings:
Surface-Water Chemistry

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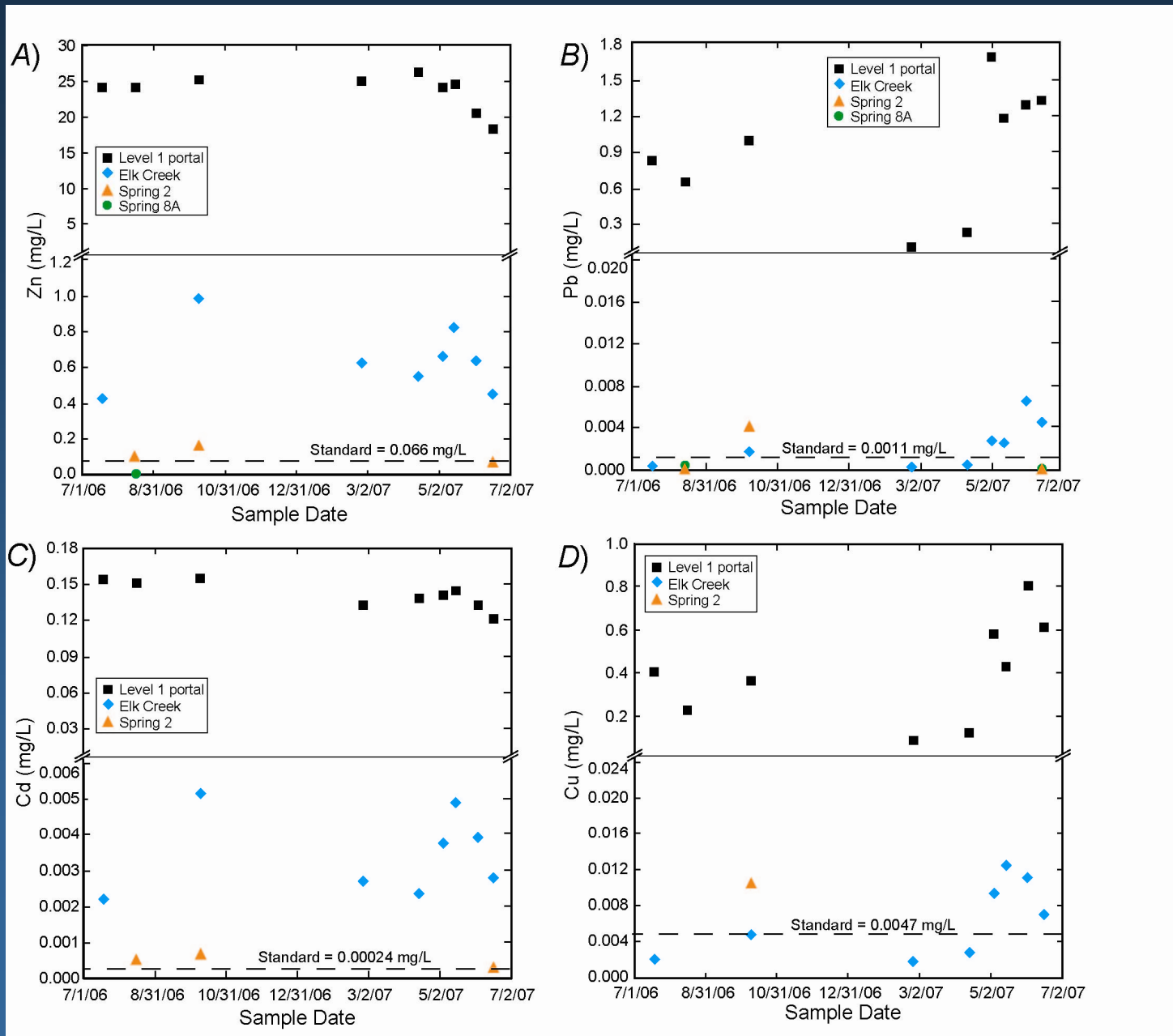
Elk Creek Metal Concentrations

- Zn and Cd concentrations consistently exceed water quality standards
- Pb, Cu, and Mn concentrations exceed water quality standards in the spring
- All metal concentrations increase during spring runoff: "spring flush"



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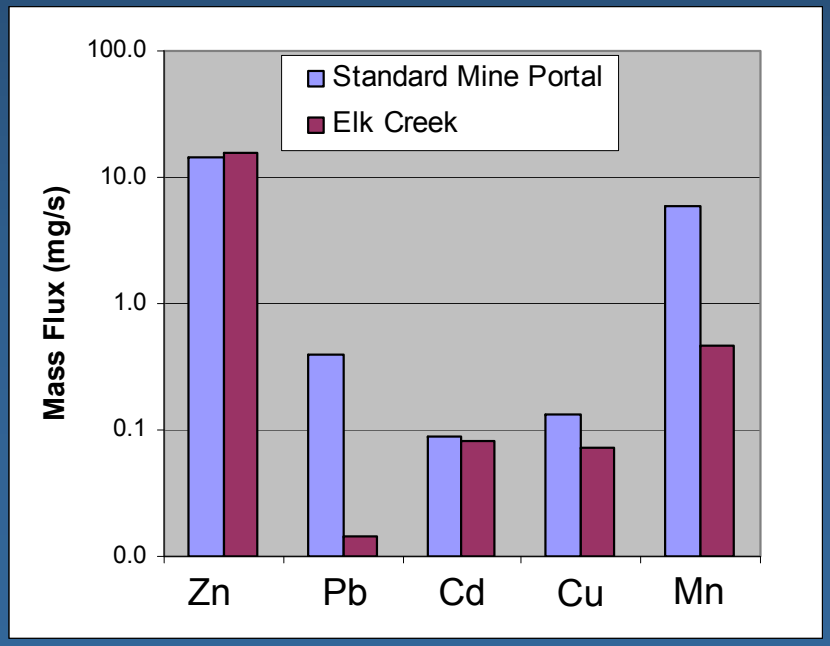
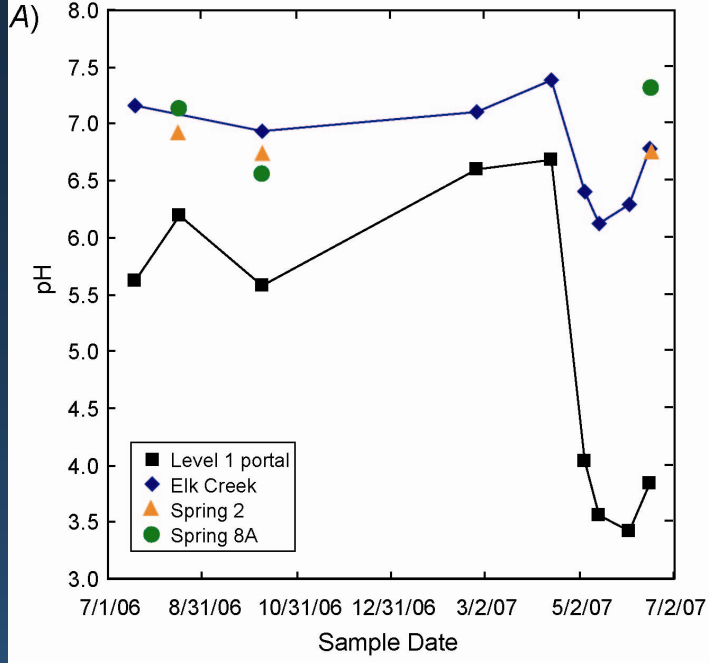
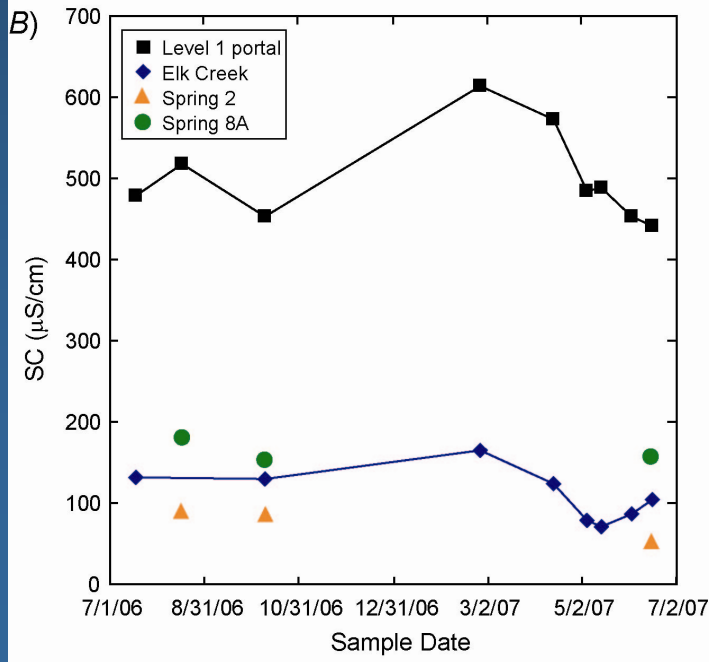
Source of Elevated Metal Concentrations

Level 1 discharge apparent source of elevated metal concentrations in Elk Creek

- Patterns of seasonal variations in stream chemistry in Level 1 discharge and Elk Creek very similar
- Estimated metal fluxes in Elk Creek in September 2006 similar to or less than those in Level 1 discharge







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Questions?
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