Using Geochemical Tracers To Characterize Groundwater Flowpaths

HARNEY BASIN STUDY ADVISORY COMMITTEE
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Uses of Geochemical Tracers:

- clarify flowpaths
- estimate travel times
- identify mixing
- identify paleowater
- calibrate numerical models
Stable Isotopes of Oxygen and Hydrogen

- Oxygen-18; $^{18}$O
- Hydrogen-2; Deuterium; $^2$H
- “stable isotopes”
- Reported in units of “per mil”
- Values are negative

Radioactive Isotope of Hydrogen

- Hydrogen-3; Tritium; $^3$H
- Half-life of 12.32 years
- “tritium”
How do we use these tools?
Deuterium ($^2$H) in winter precipitation
(Friedman et al., 2002)
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Precipitation gets “lighter” as vapor masses move inland

Condensation of cloud vapor into rain or snow preferentially removes water molecules containing the heavier isotopes, $^2$H and $^{18}$O
Deuterium (\(^2\text{H}\)) in stream baseflow
(Brooks et al., 2012)
Measured in precipitation

Half-life of 12.32 years

Pre-1945, $^3$H concentrations were about 3-7 TU

Tritium concentrations from Jurgens et al., 2012
Tritium concentrations from Jurgens et al., 2012
Tritium, decayed to 2018

TRITIUM DEAD
Multiple dates possible for some tritium concentrations
Results from Harney Basin…

so far…
Stable Isotope Approach

- Upland baseflow and cold springs are proxies for integrated annual recharge
- Wells provide discrete sample of a flowpath
- Time series characterize variability and test our assumptions
- Evaluate data w/r/t hydraulic head and hydrogeology
Stable isotopic composition of upland baseflow and upland cold springs (Temp < 12°C)
Deuterium values of winter precipitation in the Great Basin (Friedman et al., 2002)

Upland baseflow and cold springs from our study: -113 to -128
Some regional differences apparent in samples collected so far.
Regional Questions

1. Source(s) of water in the Buchanan – Crane – New Princeton corridor

2. Source(s) of water to Weaver Springs / Sunset Valley

3. Source(s) of water to Warm Springs Valley
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1. Source(s) of water in the Buchanan – Crane – New Princeton corridor

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These wells are more negative. Possibly paleowater?

Most negative sources of water measured so far

These wells are more negative. Possibly paleowater?
Water in the two wells sampled near New Princeton probably does not originate on Steens Mountain.
With existing data, the Blue Mountains (North Source) are the most likely source. Possibly a local precipitation from Stinkingwater Mountains, but we don’t have any samples yet.
All wells shifted to higher $d_{18}O$...

Mixing with thermal water source?

Paleowater falling on a different LMWL?
<table>
<thead>
<tr>
<th>Location</th>
<th>Tritium Age</th>
<th>Spec. Cond., uS/cm</th>
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</thead>
<tbody>
<tr>
<td><strong>High-elevation Steens Mountain</strong></td>
<td></td>
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<tr>
<td>Fish Lake Campground Well, 110 ft blsd</td>
<td>2013-Present; 1975-1981; 1955-1961</td>
<td>52</td>
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<td><strong>Wells near New Princeton</strong></td>
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<tr>
<td>HARN 1495, 150 ft blsd</td>
<td>pre-1945</td>
<td>1222</td>
</tr>
<tr>
<td>HARN 1494, 125 ft blsd</td>
<td>pre-1950</td>
<td>1907</td>
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<td><strong>Malheur Refuge</strong></td>
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<tr>
<td>Warm Spring nr Frenchglen</td>
<td>pre-1950</td>
<td>171</td>
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<td><strong>Warm Springs Valley</strong></td>
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<tr>
<td>Hibbard Spring</td>
<td>pre-1945</td>
<td>291</td>
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<tr>
<td>Lower Sizemore Spring</td>
<td>pre-1950</td>
<td>296</td>
</tr>
<tr>
<td>OO Cold Spring</td>
<td>pre-1945</td>
<td>272</td>
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</tbody>
</table>
2018 Geochemistry Work

- Continue quarterly sampling of springs & Blitzen River on MNWR
- Sample additional upland springs and wells to fill gaps
- Select DEQ samples for tritium and stable isotope analysis
- Evaluate geochemistry data collected by Crane HS
- Collect new age-tracer data from selected wells and springs
References Cited

