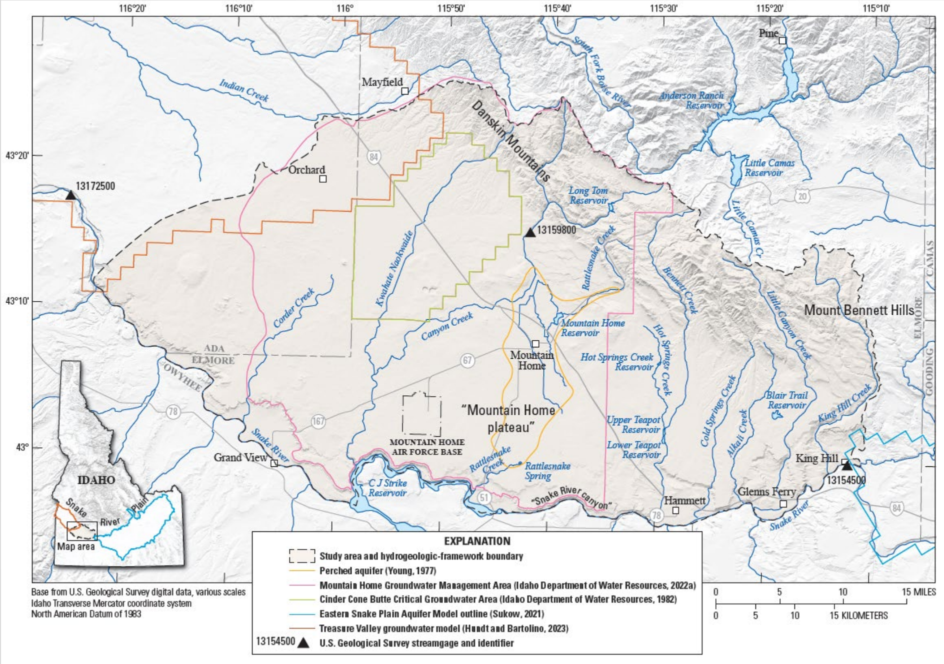
Hydrogeologic Framework of the Mountain Home Area

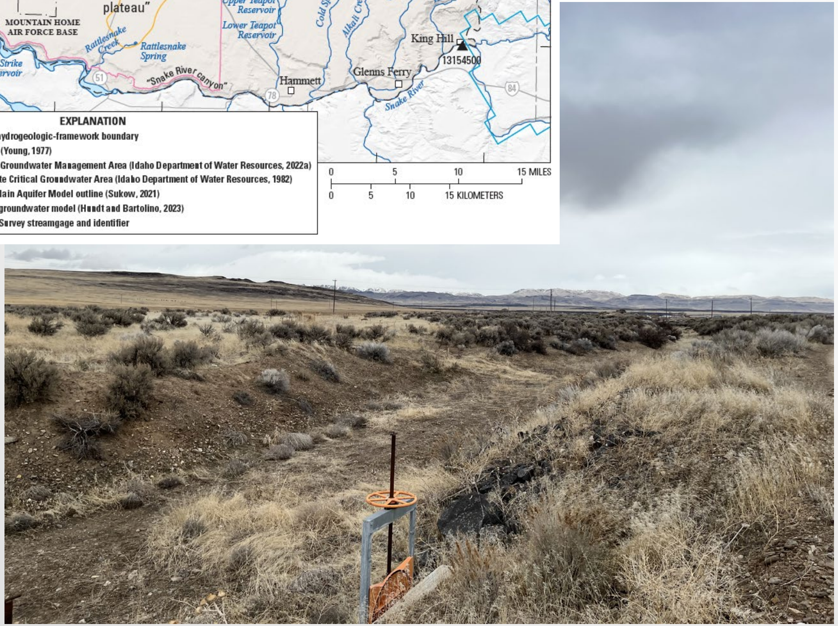
U.S. Department of the Interior
U.S. Geological Survey

In cooperation with the
Idaho Department of Water Resources

Lauren Zinsser
lzinsser@usgs.gov

Scott Ducar
sducar@usgs.gov





Motivation

- Surface water resources are limited
- Groundwater levels are declining

Goals

- Improve hydrogeologic understanding
- Inform water management
- Support future groundwater-flow modeling

USGS

Approach

- Hydrogeologic framework, [Zinsser and Ducar (2025)]
  - Groundwater occurrence, movement, change
    - Hydrogeologic framework model
    - Groundwater-level synoptic
    - Long-term groundwater level monitoring
- Groundwater budget – [Thomas (2026)]

USGS

Groundwater Occurrence: Hydrogeologic Framework Model

Methods

- Literature review
- Digitize well-driller reports
- Interpret hydrogeologic units
- Develop 3D hydrogeologic framework model
- Create conceptual diagrams

Previous Hydrogeologic Work

First extensive hydrogeologic investigation specific to Mountain Home:

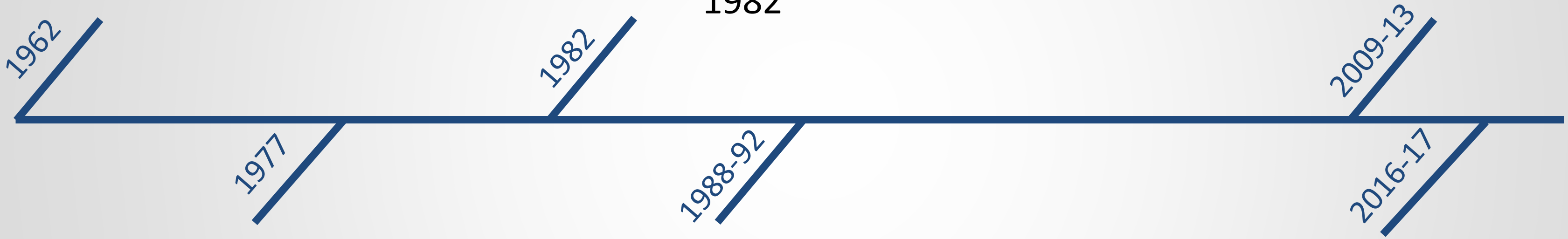
- Ralston and Chapman, 1962

Review of hydrogeology around Cinder Cone Butte and included groundwater-levels:

- Norton and others, 1982

Mayfield studies:

- Aquifer recharge: Tesch and Vincent, 2009, Hopkins, 2013
- Geology: Phillips and others, 2012
- Hydrogeologic conditions: Welhan, 2012 and Tesch, 2013



Groundwater levels, delineated perched groundwater extent, and first to describe declining groundwater levels near Cinder Cone Butte:

- Young, 1977

Snake River Plain regional aquifer studies:

- GW-levels: Lindholm and others, 1988
- GW budget and flow model: Newton, 1991
- Geohydro Framework: Whitehead 1992

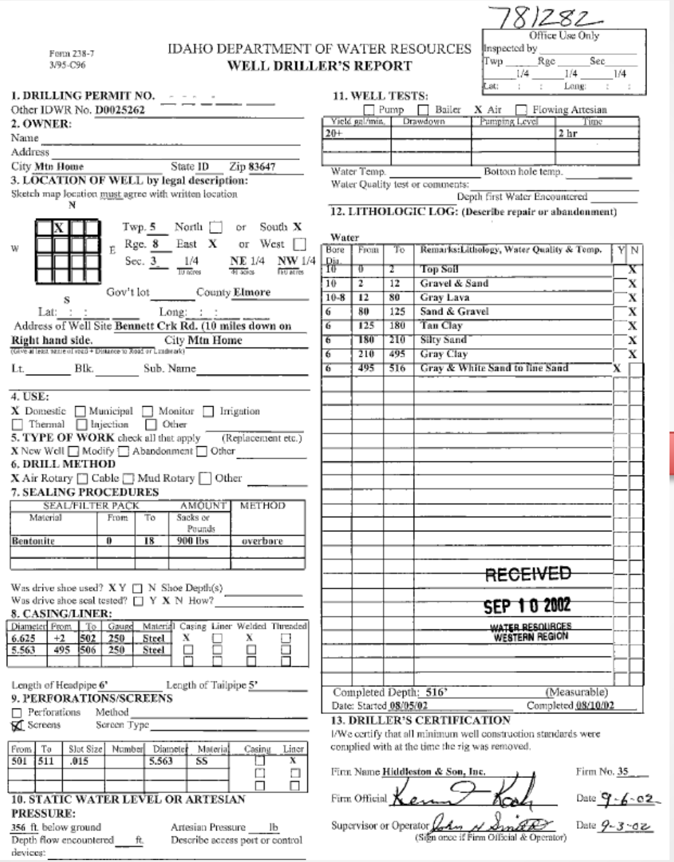
Water supply studies MHAFB and Elmore County:

- SPF, 2016
- SPF, 2017

USGS

Borehole database

- Digitize paper logs
  - 540 boreholes
  - Location details
  - Lithology
  - Water level
  - Well construction
- Lithologies used to define hydrogeologic unit and build 3D model



781282

Office Use Only
Inspected by ______
Twp ____ Rge ____ Sec ____
____1/4 ____1/4 ____1/4
Lat: : : Long: : :

Form 238-7
3/95-C96

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

1. DRILLING PERMIT NO. __ __ __ ____ ____
Other IDWR No. **D0025262**

2. OWNER:
Name ______
Address ______
City **Mtn Home** State **ID** Zip **83647**

3. LOCATION OF WELL by legal description:
Sketch map location must agree with written location
N W E S
Twp. **5** North ☐ or South **X**
Rge. **8** East **X** or West ☐
Sec. **3** ___ 1/4 (10 acres) **NE** 1/4 (40 acres) **NW** 1/4 (160 acres)
Gov't lot ____ County **Elmore**
Lat: : : Long: : :
Address of Well Site **Bennett Crk Rd. (10 miles down on Right hand side.** City **Mtn Home**
(Give at least name of road + Distance to Road or Landmark)
Lt. ____ Blk. ____ Sub. Name ______

4. USE:
X Domestic ☐ Municipal ☐ Monitor ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other ______

5. TYPE OF WORK check all that apply (Replacement etc.)
X New Well ☐ Modify ☐ Abandonment ☐ Other ______

6. DRILL METHOD
X Air Rotary ☐ Cable ☐ Mud Rotary ☐ Other ______

7. SEALING PROCEDURES

SEAL/FILTER PACK			AMOUNT	METHOD
Material	From	To	Sacks or Pounds	
Bentonite	0	18	900 lbs	overbore

Was drive shoe used? X Y ☐ N Shoe Depth(s) ______
Was drive shoe seal tested? ☐ Y X N How? ______

8. CASING/LINER:

Diameter	From	To	Gauge	Material	Casing	Liner	Welded	Threaded
6.625	+2	502	250	Steel	X	☐	X	☐
5.563	495	506	250	Steel	☐	☐	☐	☐
					☐	☐	☐	☐

Length of Headpipe **6'** Length of Tailpipe **5'**

9. PERFORATIONS/SCREENS
☐ Perforations Method ______
☒ Screens Screen Type ______

From	To	Slot Size	Number	Diameter	Material	Casing	Liner
501	511	.015		5.563	SS	☐	X
						☐	☐
						☐	☐

10. STATIC WATER LEVEL OR ARTESIAN PRESSURE:
356 ft. below ground Artesian Pressure ___ lb
Depth flow encountered ___ ft. Describe access port or control devices: ______

11. WELL TESTS:
☐ Pump ☐ Bailer X Air ☐ Flowing Artesian

Yield gal/min.	Drawdown	Pumping Level	Time
20+			2 hr

Water Temp. ______ Bottom hole temp. ______
Water Quality test or comments: ______
Depth first Water Encountered ______

12. LITHOLOGIC LOG: (Describe repair or abandonment)

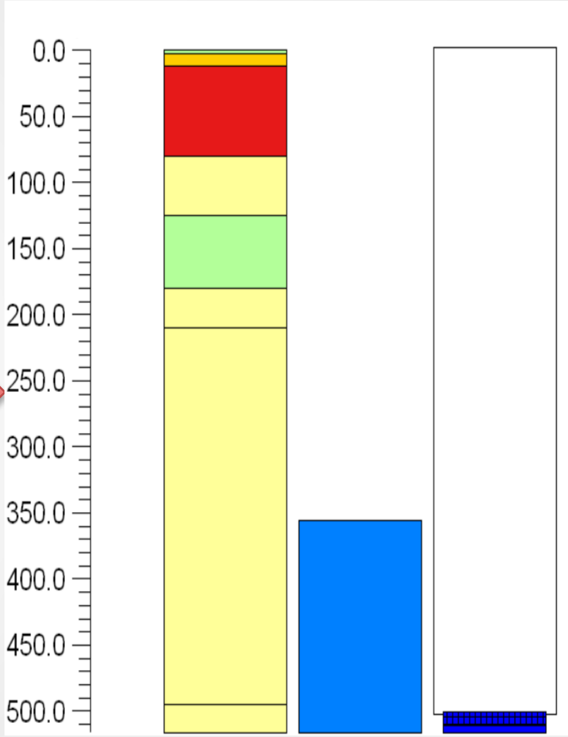
Bore Dia.	From	To	Remarks: Lithology, Water Quality & Temp.	Water Y	Water N
10	0	2	Top Soil		X
10	2	12	Gravel & Sand		X
10-8	12	80	Gray Lava		X
6	80	125	Sand & Gravel		X
6	125	180	Tan Clay		X
6	180	210	Silty Sand		X
6	210	495	Gray Clay		X
6	495	516	Gray & White Sand to fine Sand	X	

RECEIVED
SEP 10 2002
WATER RESOURCES
WESTERN REGION

Completed Depth: 516' (Measurable)
Date: Started 08/05/02 Completed 08/10/02

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name **Hiddleston & Son, Inc.** Firm No. 35
Firm Official ______ Date 9-6-02
Supervisor or Operator ______ Date 9-3-02
(Sign once if Firm Official & Operator)

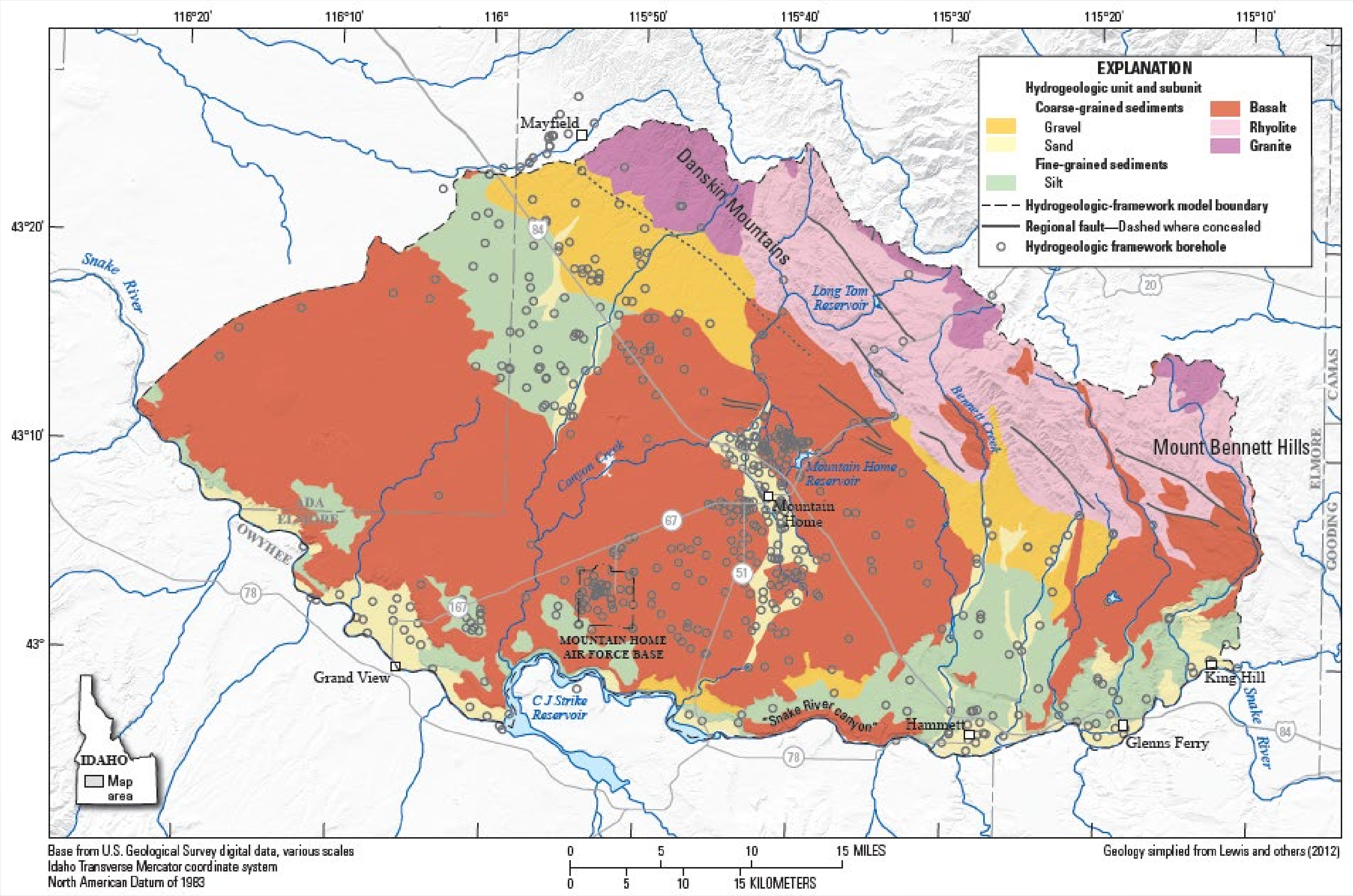


USGS

Hydrogeologic Units

1. Granite
2. Rhyolite
3. Basalt*
4. Fine-grained sediments*
5. Coarse-grained sediments

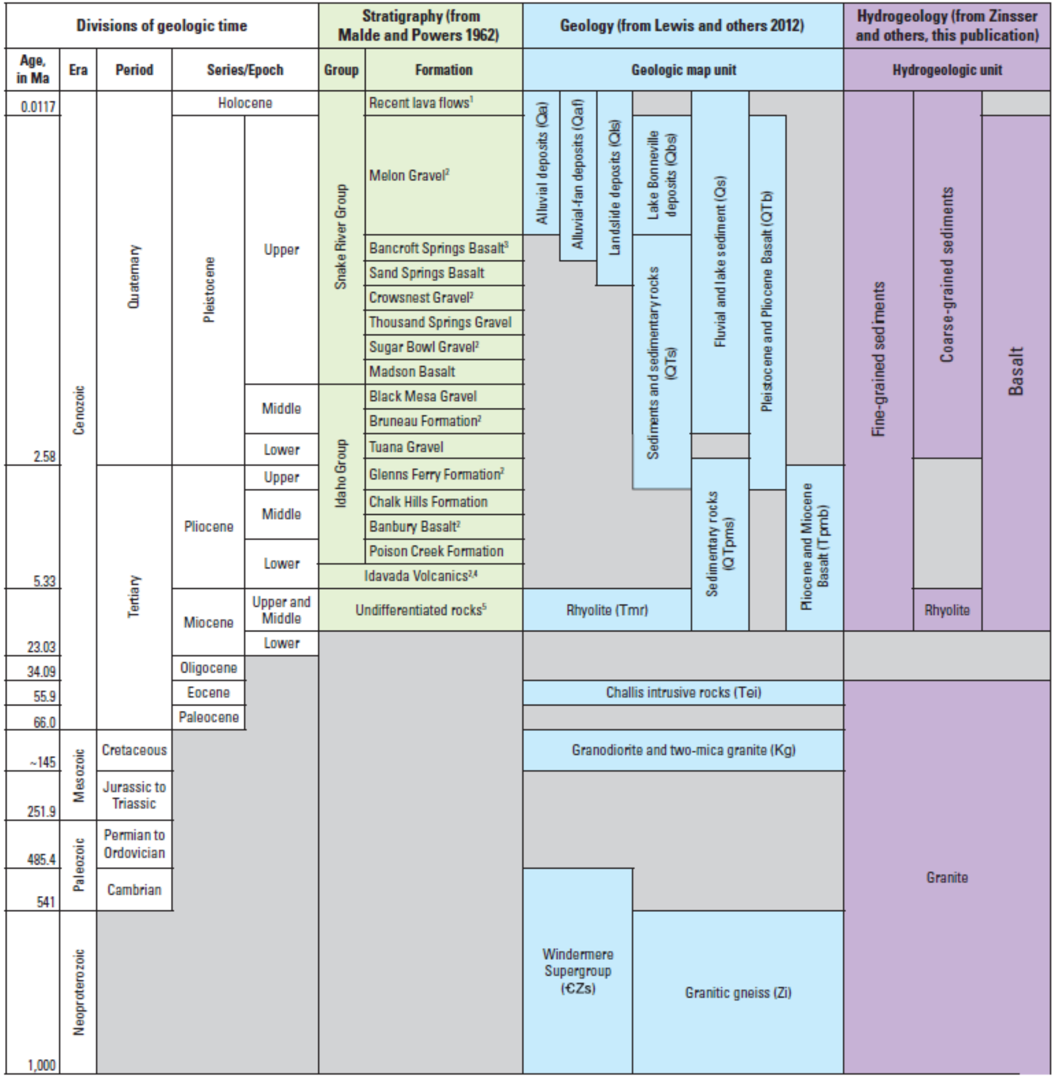
*host main regional aquifer



Hydrogeologic Units

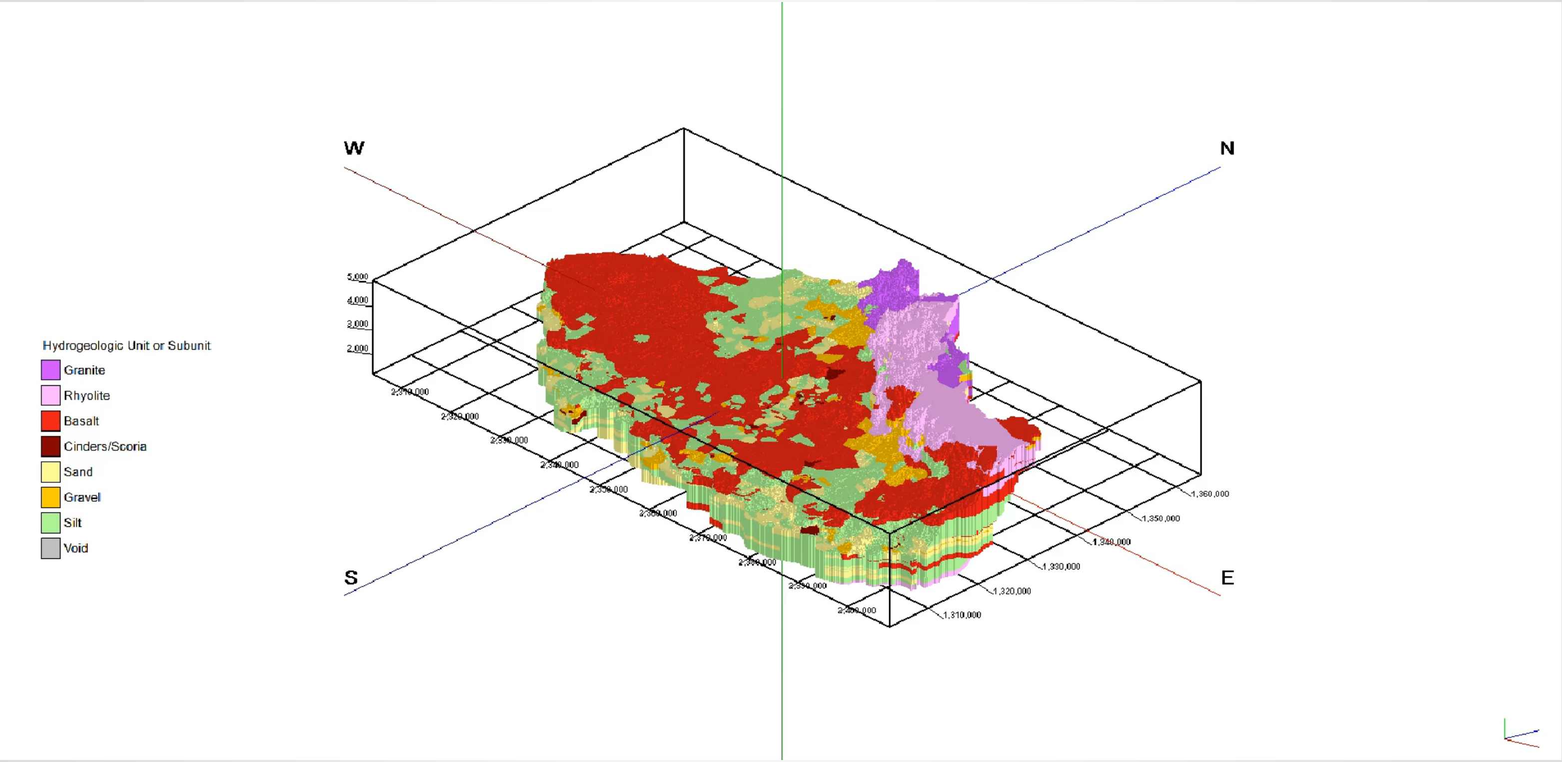
1. Granite
2. Rhyolite
3. Basalt*
4. Fine-grained sediments*
5. Coarse-grained sediments

*host main regional aquifer



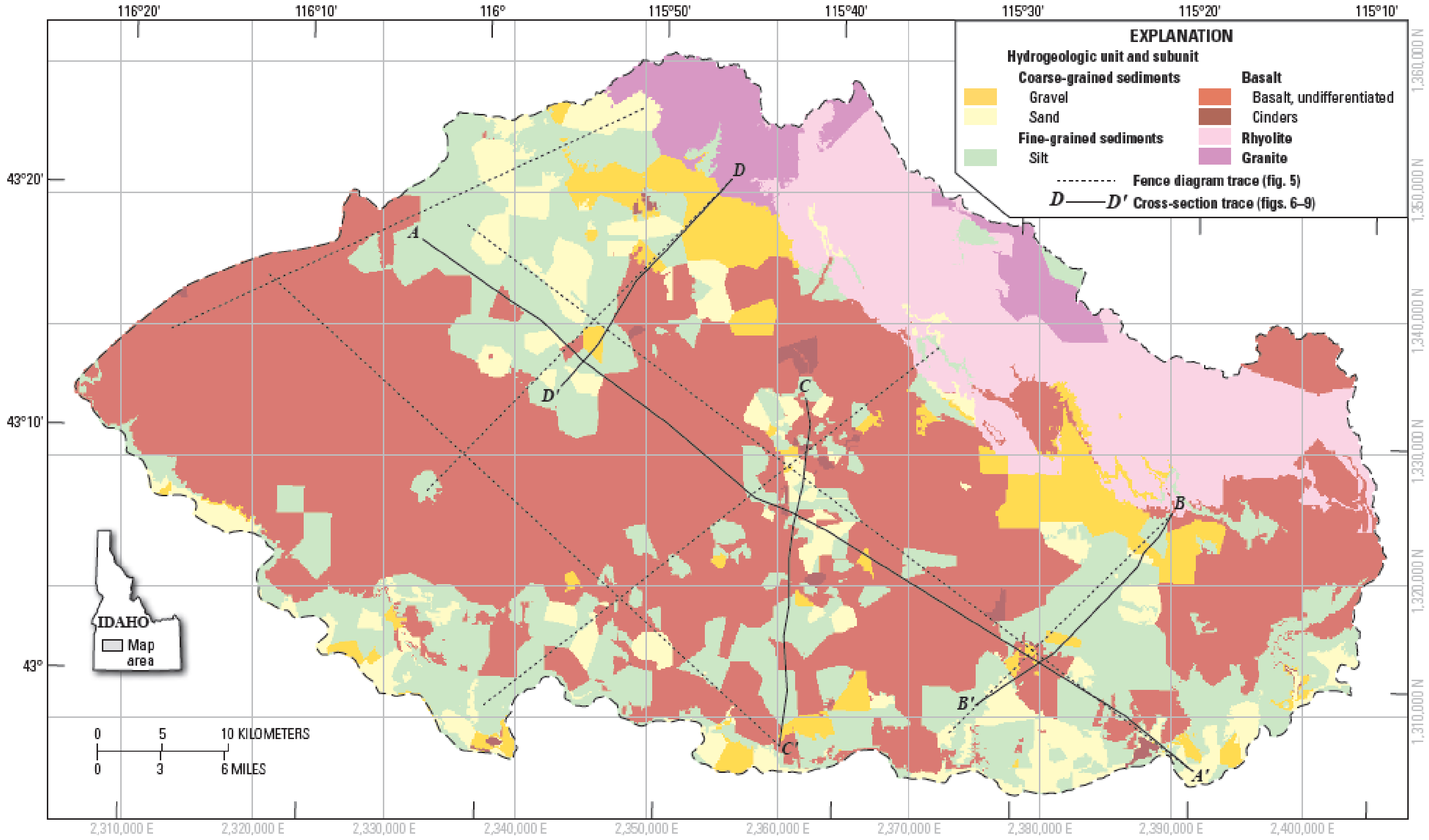
USGS

3D Hydrogeologic Framework Model



USGS Use model and database to understand occurrence, connectivity, and properties of units

3D Hydrogeologic Framework Model

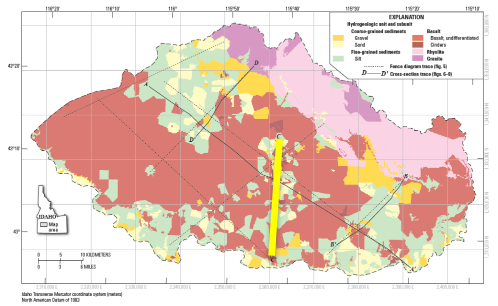


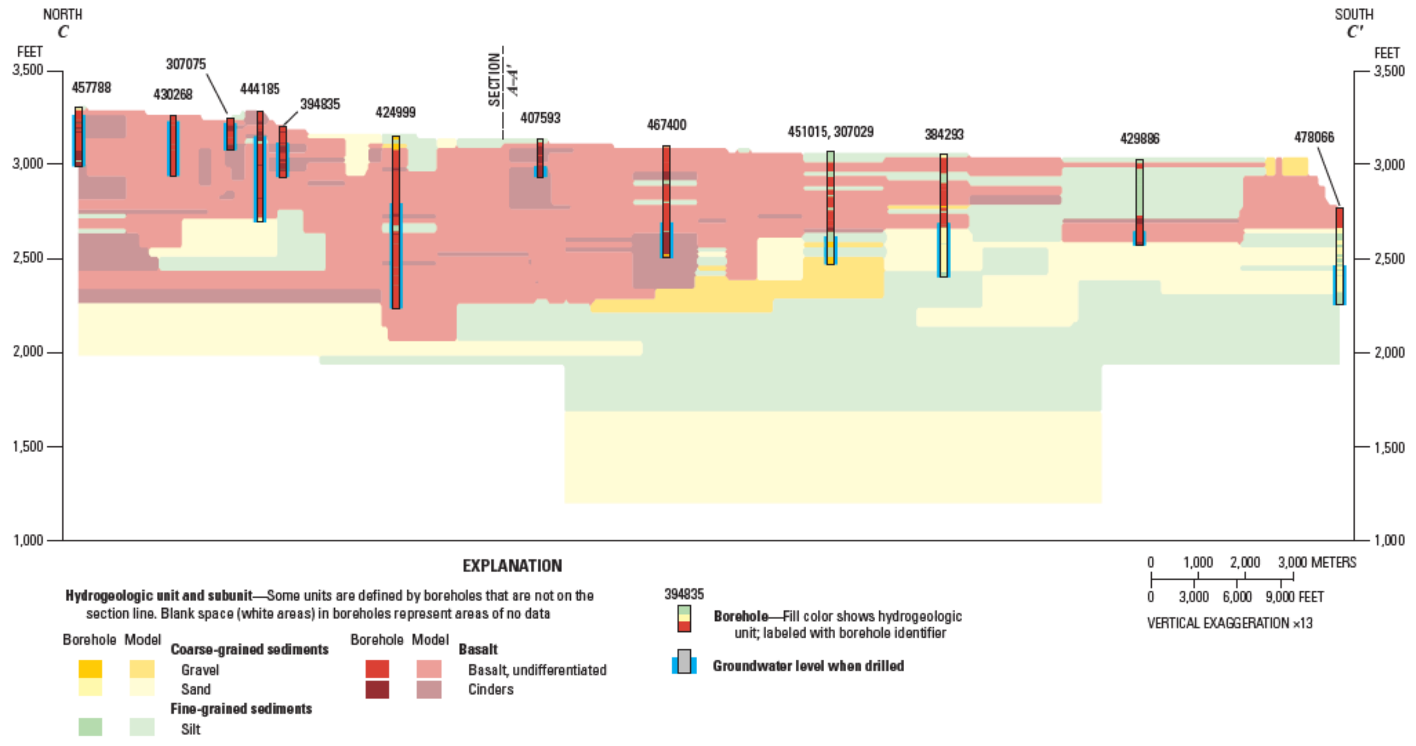
Idaho Transverse Mercator coordinate system (meters)
North American Datum of 1983

USGS

Central cross-section

- Fine-grained sediments underlie basalt flows
- Basalt and sediments contain perched groundwater

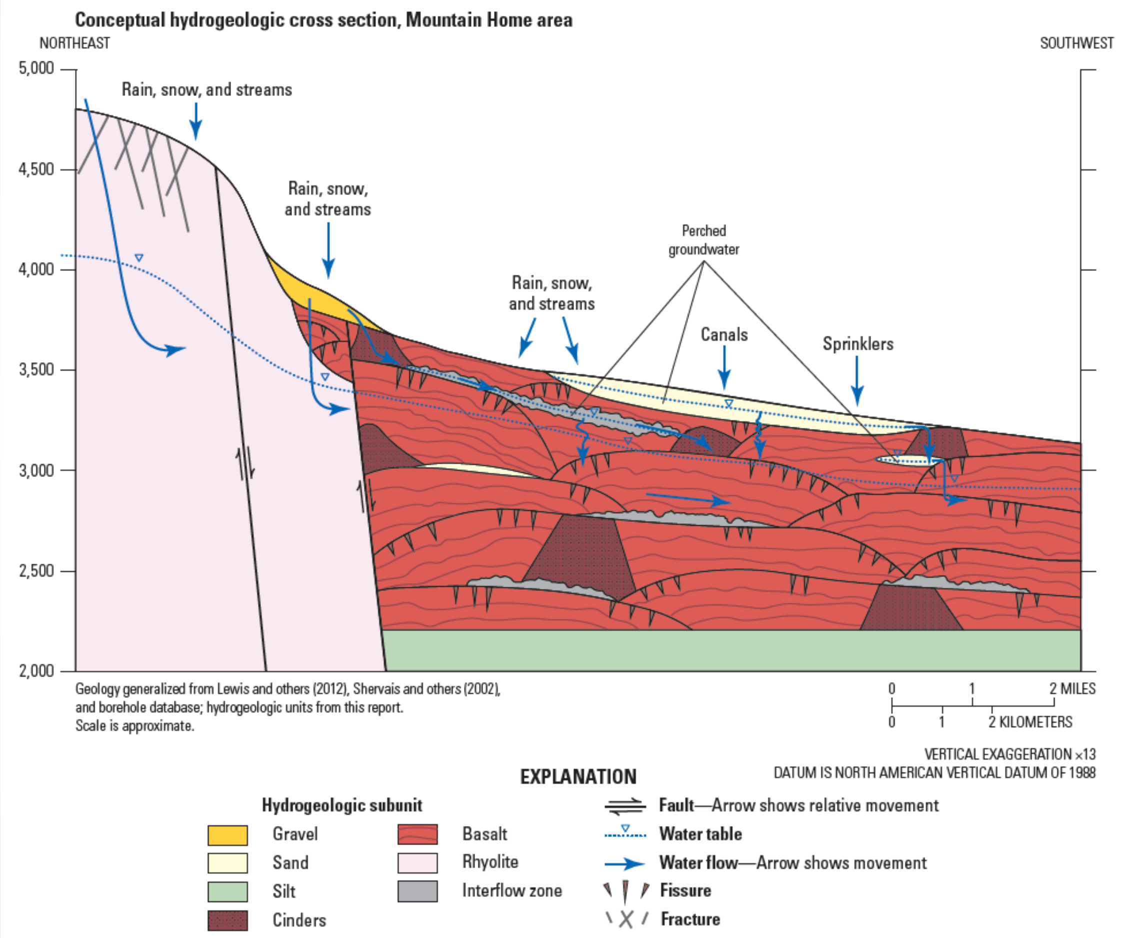




USGS

Conceptual Diagrams: Groundwater Movement Through Basalt

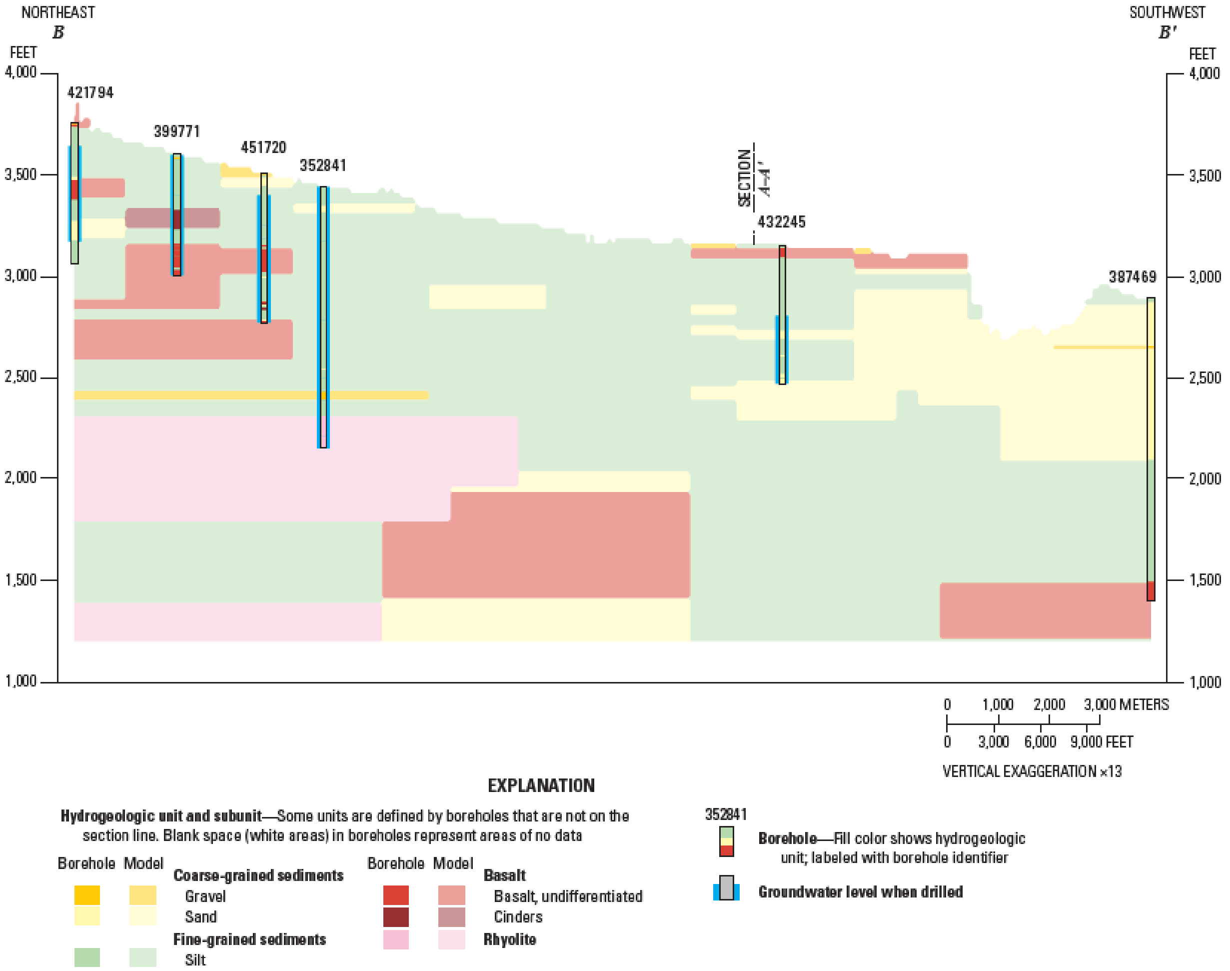
- Heterogeneity in basalt unit impacts movement:
  - Vertical movement through fissures, near-vent scoria
  - Horizontal movement through interflow zones, cinder horizons, coarse sediment interbeds
- Perching associated with surface water recharge

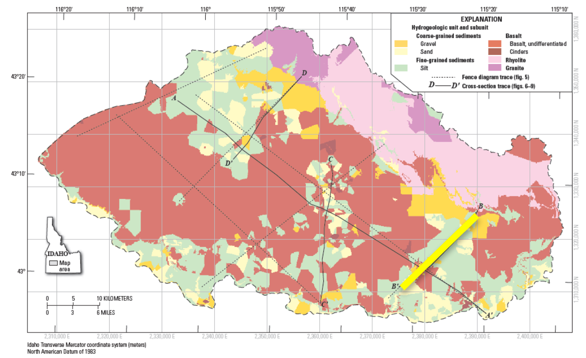


USGS

East cross-section

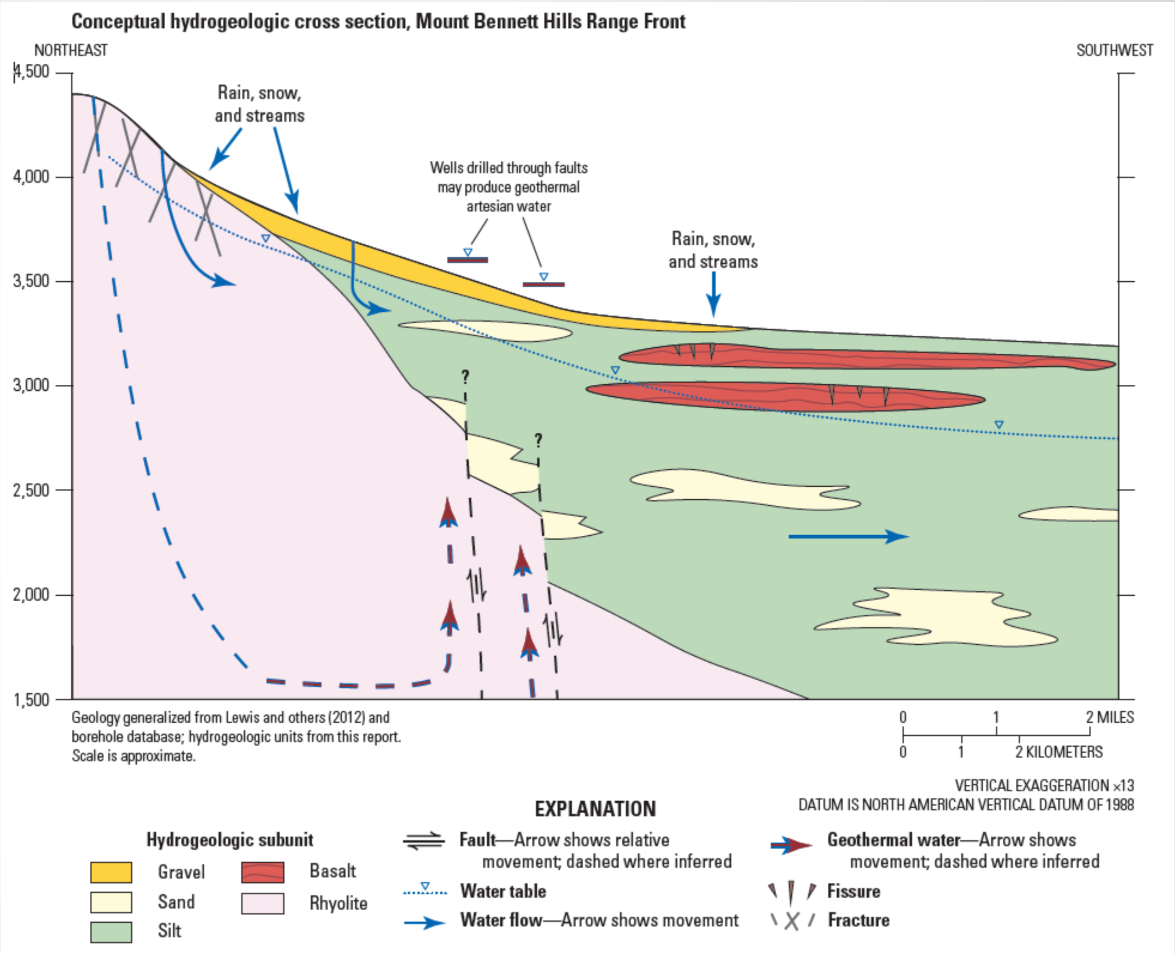
- Fine-grained sediments dominate area
- Rhyolite intersected in flowing geothermal wells





Conceptual Diagrams: Effects of Faulting on Groundwater

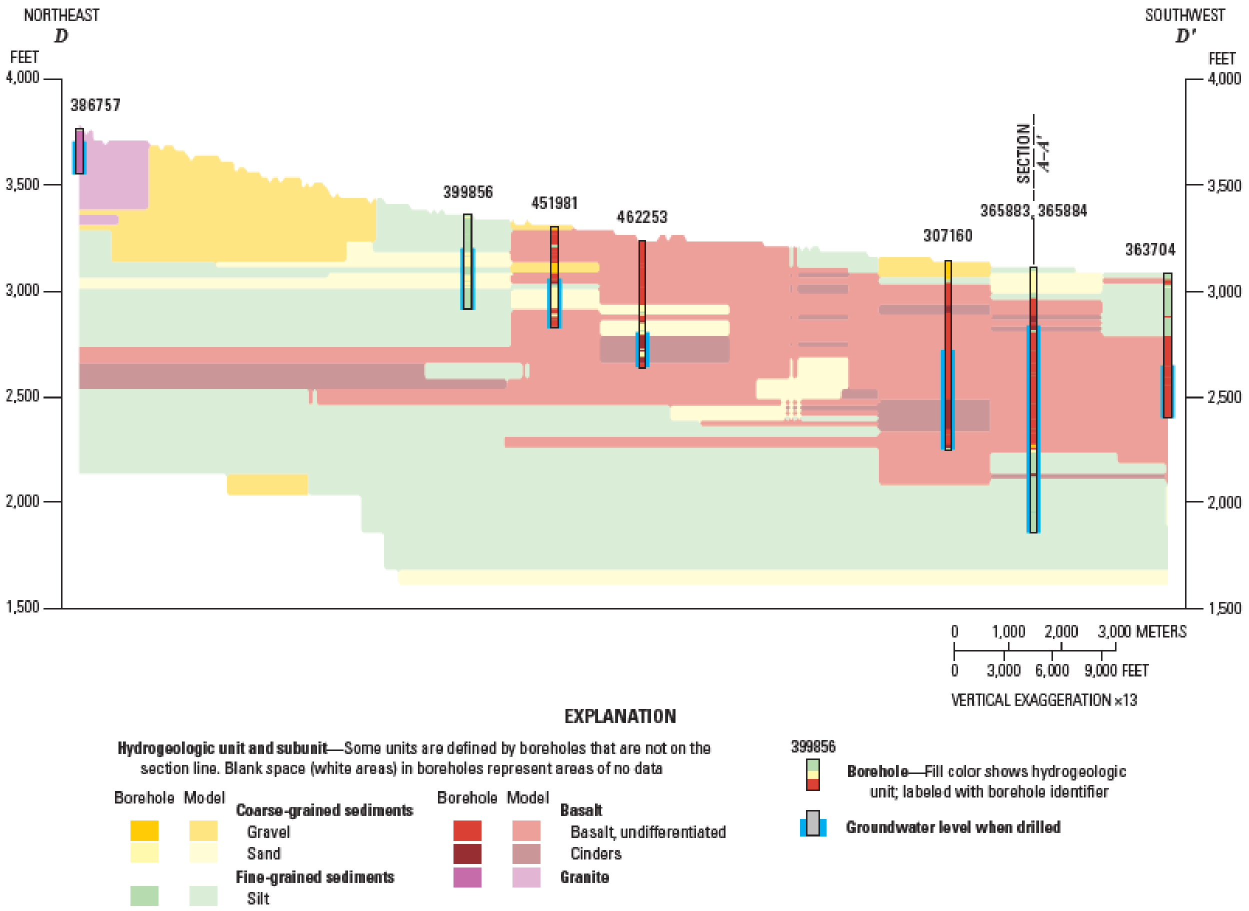
- Represent more realistic regional geology at depth
- Faults can impede or enhance groundwater movement
  - Some faults associated with artesian, geothermal water
  - Some faults associated with offset water table

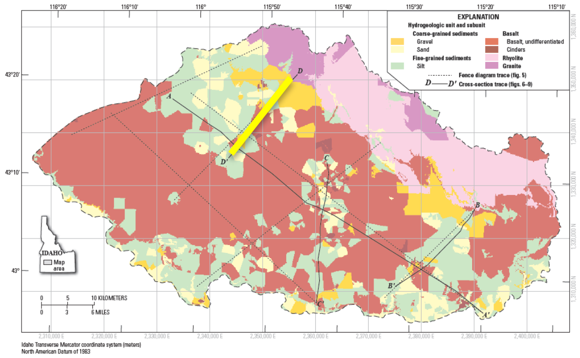


USGS

West cross-section

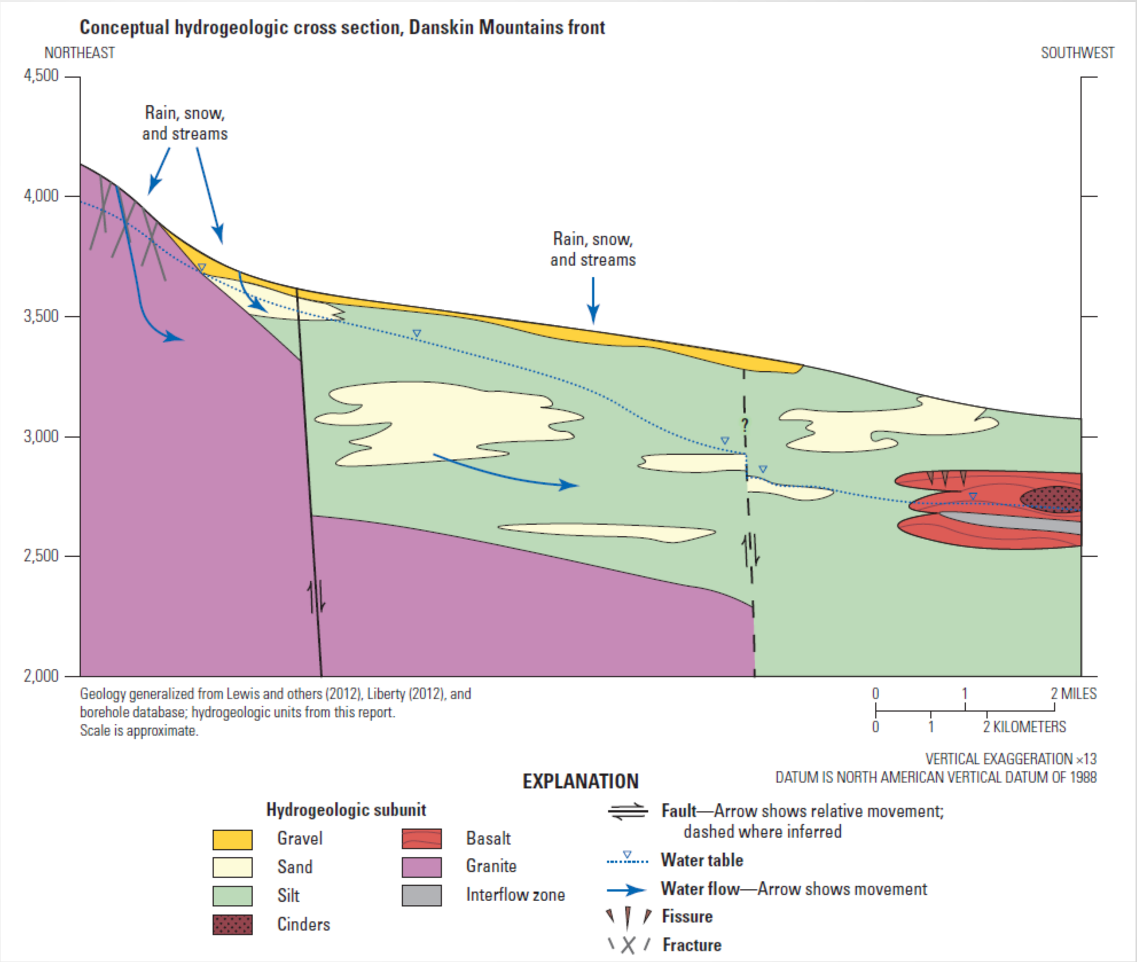
- Granitic rock in foothills
- Extensive basalt flows
- Fine-grained sediment underlie basalt





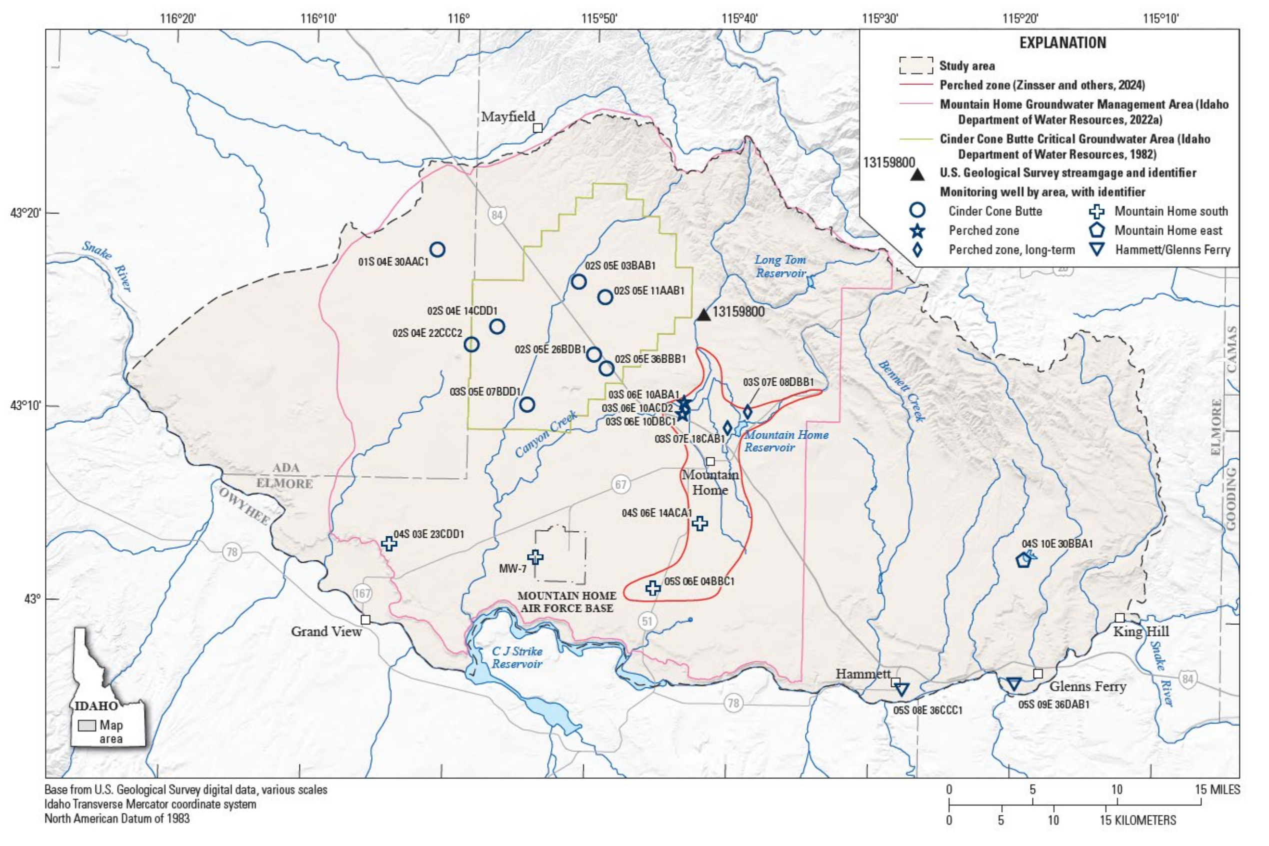
Conceptual Diagrams: Effects of Faulting on Groundwater

- Represent more realistic regional geology at depth
- Faults can impede or enhance groundwater movement
  - Some faults associated with artesian, geothermal water
  - Some faults associated with offset water table



Groundwater Change: Long-Term Groundwater Levels

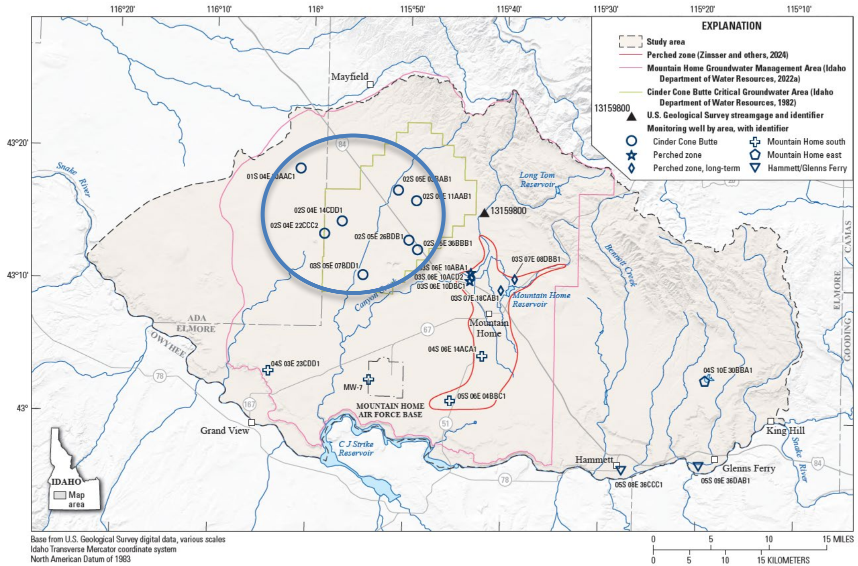
- IDWR network of long-term records
- Manual measurements and continuous measurements
- Data available in IDWR [Ground Water Data Portal]

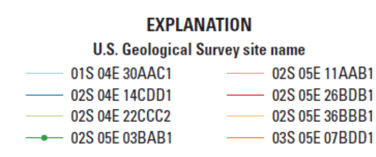


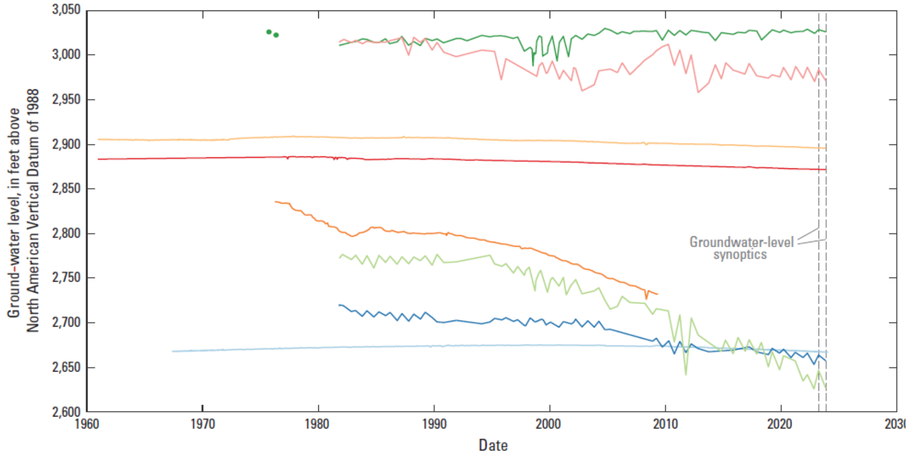
USGS

Long-Term Groundwater Levels: Cinder Cone Butte

- Water level declines since 1980
- Greatest declines in southwestern part of CGWA (over 100 ft since 1980)
- North of I-84 no or slight decline
- Well in northwest declines since 2000



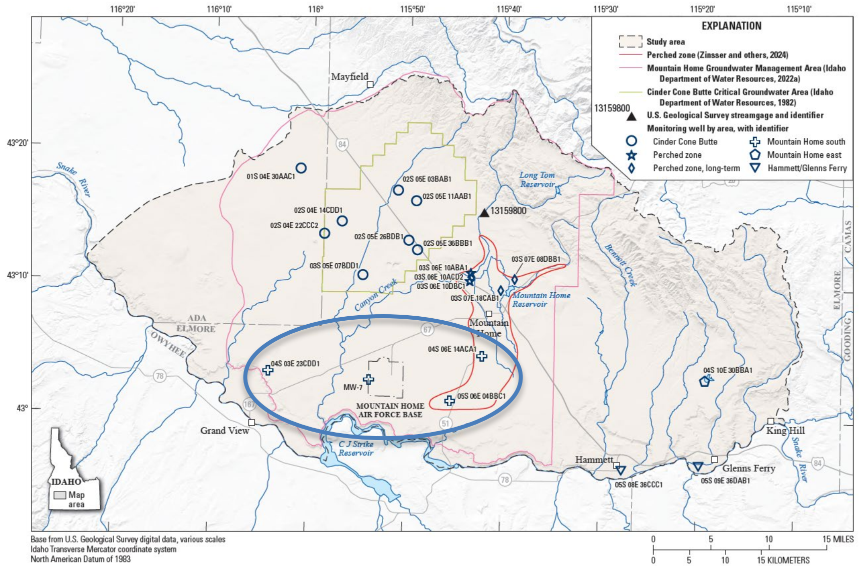


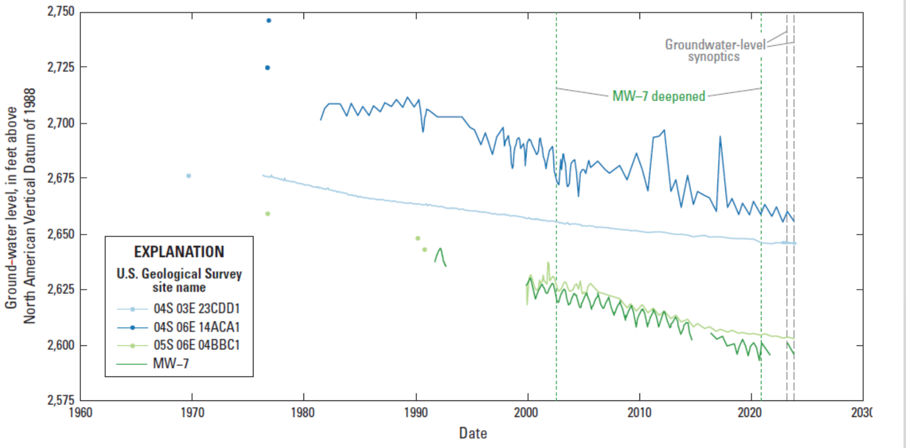


USGS

Long-Term Groundwater Levels: Mountain Home South

- Water level declines since 1980
- Over 50 ft of declines






Modernizing Idaho's Water Infrastructure

An Ongoing Story Series on Idaho Water Resource Board Regional Water Sustainability Projects ISSUE NO. 2

MHAFB Water Resilience Project

Project description: Mountain Home Air Force Base (MHAFB) currently relies on groundwater wells to meet its municipal water demand for military and residential needs. Water is currently pumped from the Mountain Home Plateau Aquifer, which has been declining at an unsustainable rate. Furthermore, some MHAFB wells have been closed due to concerns about nitrate contamination.

Given the importance of MHAFB to national security and its estimated $1 billion annual contribution to the Idaho economy, the Idaho Water Resource Board (IWRB) has been working for more than 10 years to develop a long-term, sustainable water supply to the base.

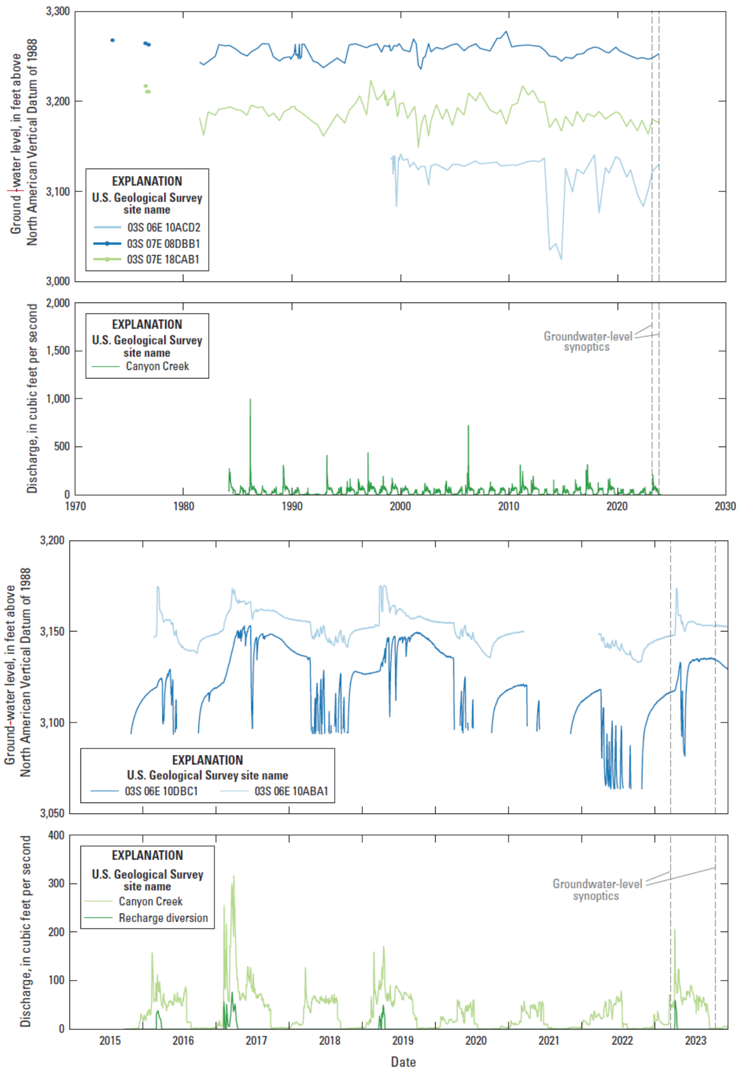
IMCO welds sections of HDPE pipe together along Idaho State Highway 167. The new pipeline will convey water to Mountain Home AFB. (photo by Steve Stuebner/IWRB)

https://idwr.idaho.gov/iwrb/projects/mhafb/

USGS

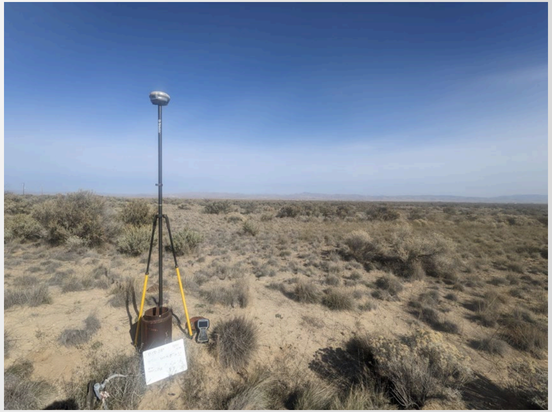
Long-Term Groundwater Levels: Perched Groundwater Zone

- Periods of decline followed by recovery
- Related to the abundance or lack of surface water
- Managed groundwater recharge started in 2016
- Sharp increase in groundwater level during times of diversion
- Surface-water supply is important to recharge perched groundwater zone



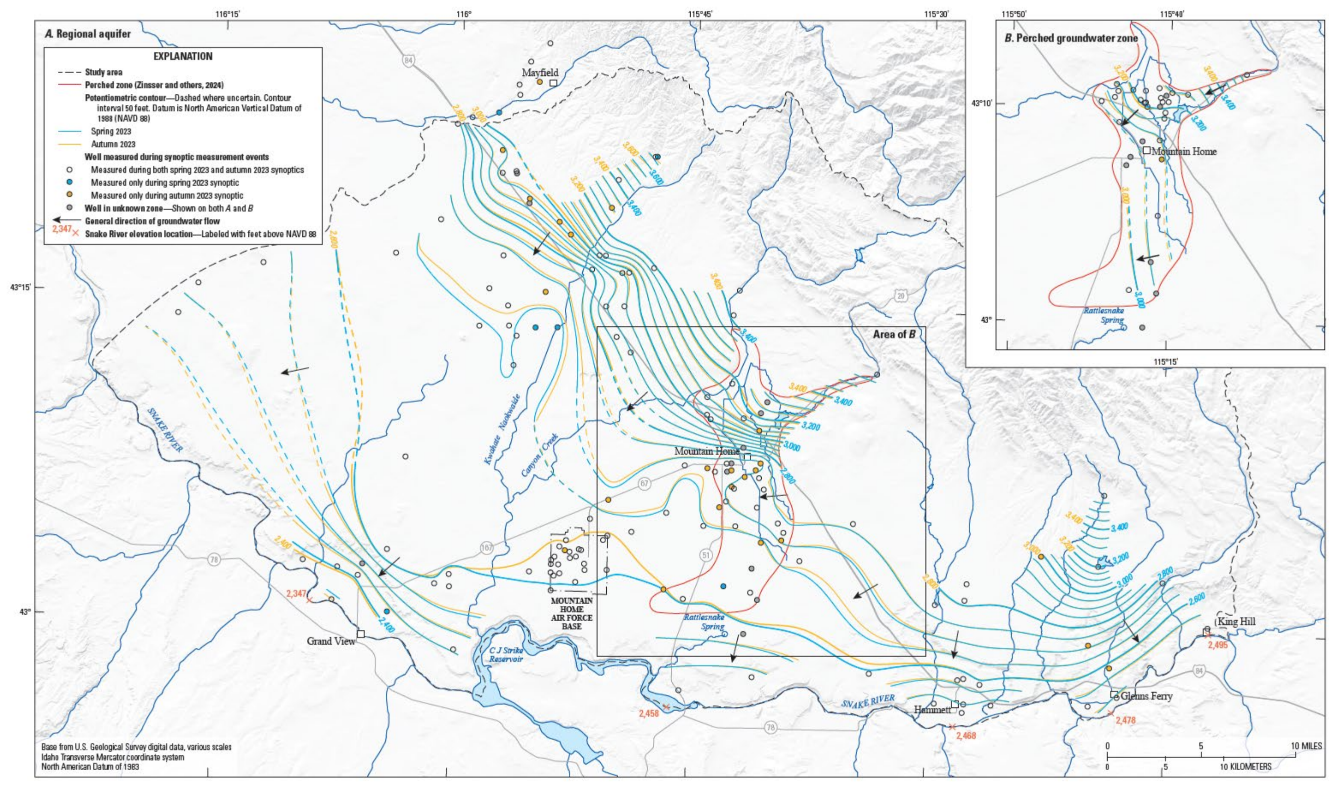
Groundwater Movement and Change: Groundwater-Level Synoptics

- USGS and IDWR measured water levels in 180 wells
  - Spring and autumn 2023
  - Surveyed wellheads
- Developed water-level maps
  - Regional and perched surfaces
  - Cokriging or spline interpolation
- Developed change maps
  - Spring to autumn 2023
- Data in USGS NWIS and IDWR Ground Water Data Portal



Water Table: Regional Aquifer

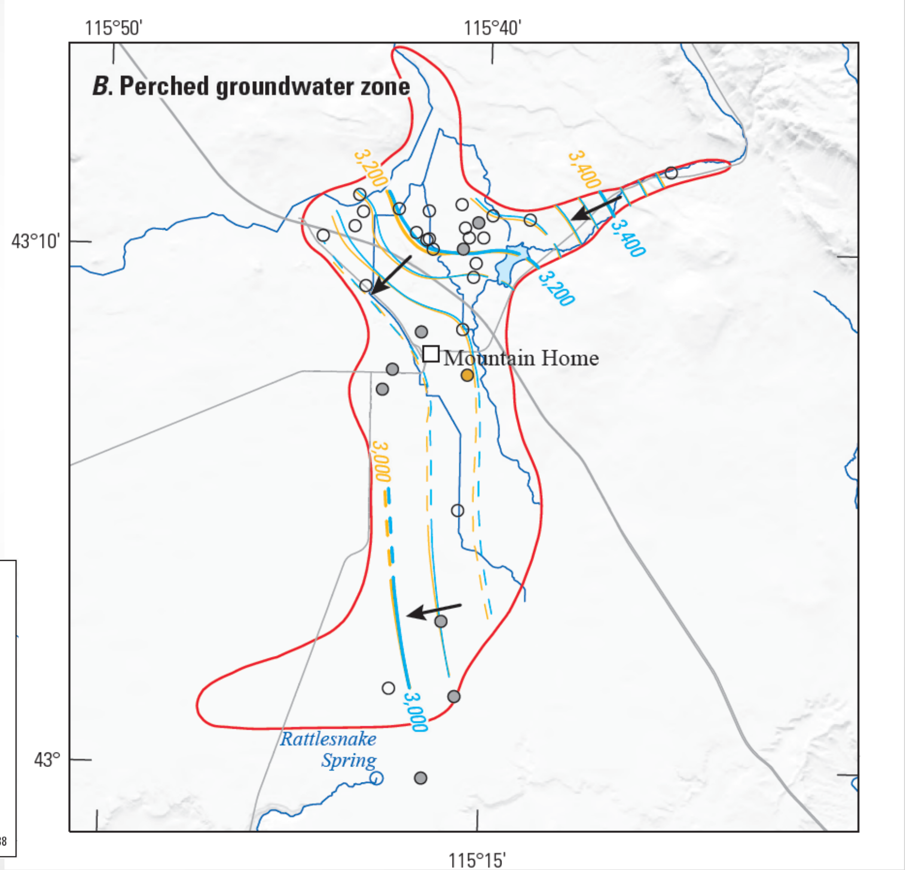
- Depth to water 150 to 765 ft
- Groundwater flows south-southwest
- Gradients steep in north, flatten, then steepen at Snake River canyon
- Groundwater discharge at Snake River based on altitudes



USGS

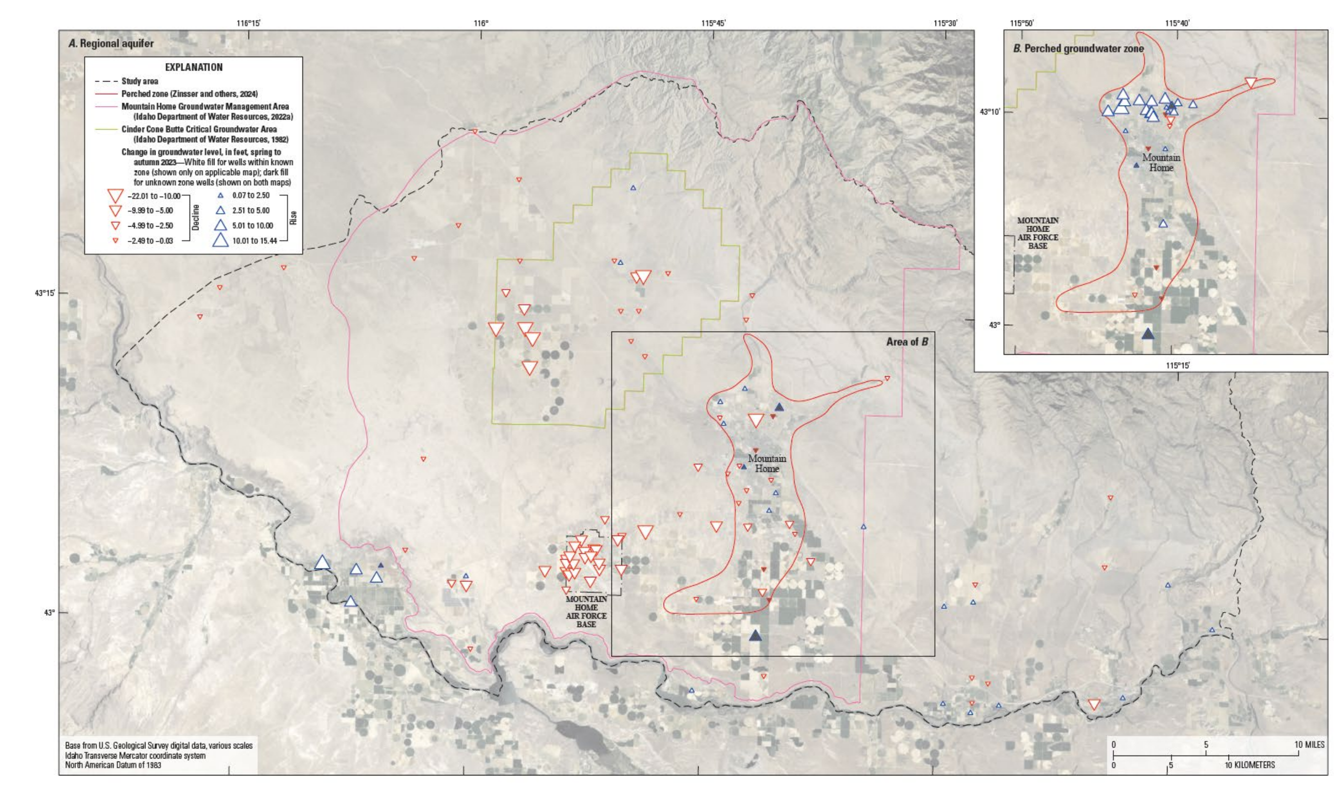
Water Table: Perched Groundwater Zone

- Depth to water 30 to 100 ft
- Multiple perched zones
- Westerly flow south of I-84
- Approximately 50 ft above regional aquifer
- Additional perched groundwater in Cinder Cone Butte CGWA and below MHAFB



Water Level Change: Spring to Autumn 2023

- Declines in Cinder Cone Butte CGWA and near MHAFB
- Less change east of Mountain Home and far west
- Rise in Snake River canyon
- Rise in perched area with variability related to heterogeneity, groundwater use, and surface water recharge



USGS

Groundwater Storage Change: Spring to Autumn 2023

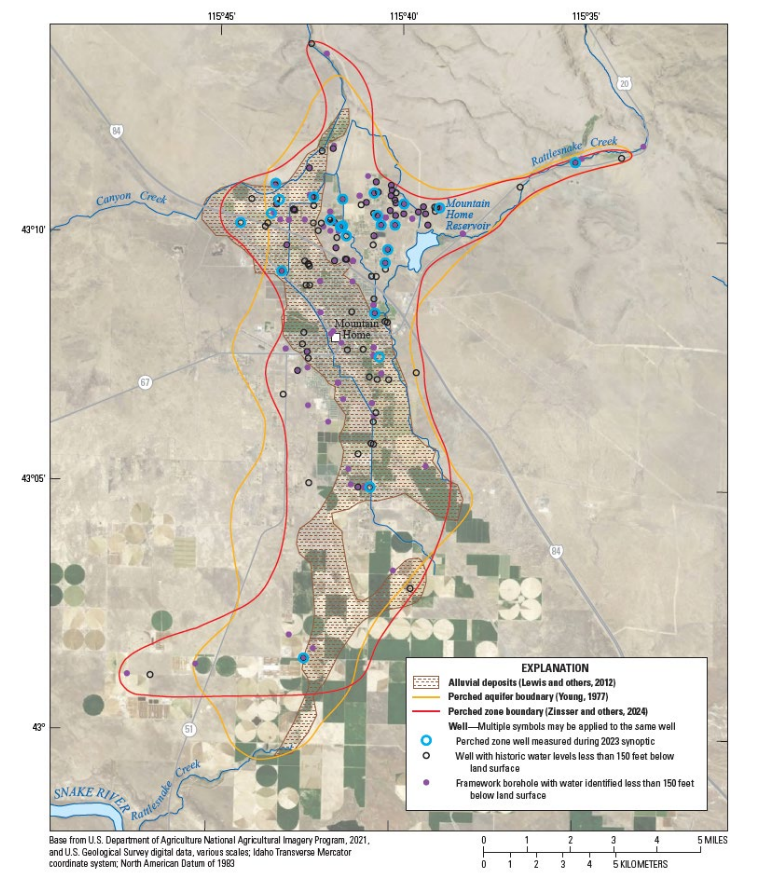
- Developed groundwater level change raster
- Intersected autumn 2023 water level with 3D model to calculate unit volume
- Estimated storage change using feet of water level change and unit storativity
- Storage change is consistent with annual withdrawal estimates (43,000 acre-ft SPF, 2017) and an annual water-budget deficit (30,900 acre-ft Harrington, 2004)

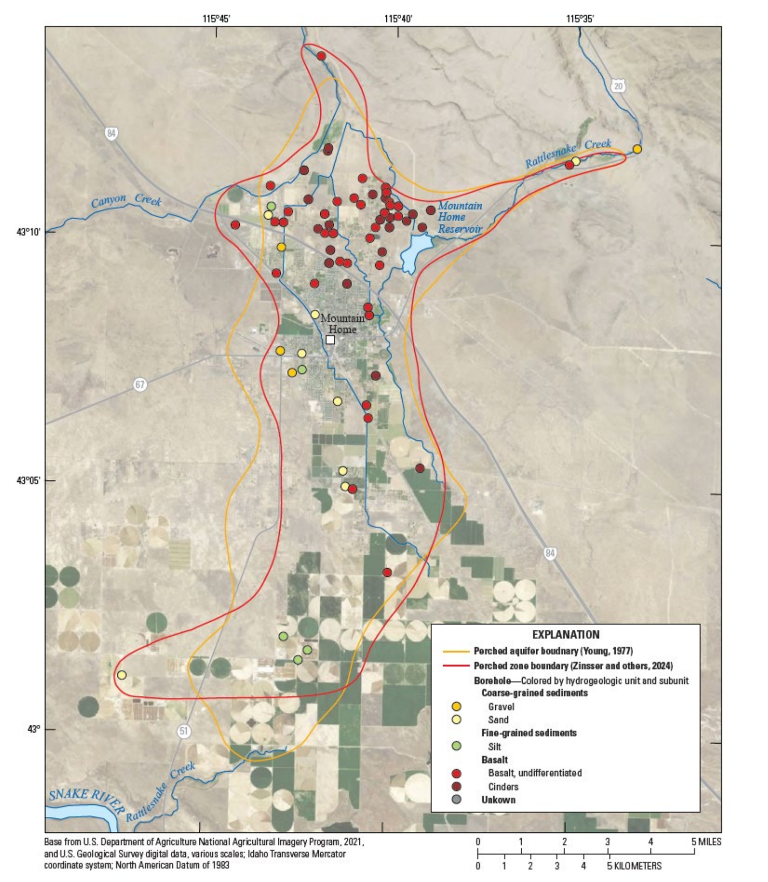
Table 6. Estimated change in groundwater storage between spring and autumn 2023, Mountain Home area, southern Idaho.

[Data are from Zinsser and others, 2024]

Area	Storage change: Estimated using the storativity presented in table 2		Storage change: Estimated using uniform specific yield of 0.1	Area (acres)
	Total change (acre-feet)	Change range (acre-feet)	Total change (acre-feet)	
Cinder Cone Butte Critical Groundwater Area	–13,620	–3,620 to –23,250	–10,080	80,080
Mountain Home Groundwater Management Area	–23,690	–5,240 to –41,680	–18,910	359,120
Combined groundwater management areas	–37,310	–8,860 to –64,930	–28,990	439,200
Regional aquifer excluding the combined groundwater management areas	4,810	1,230 to 10,670	2,550	265,140
Perched groundwater zone	6,390	1,410 to 11,690	4,820	34,020

Perched Groundwater Zone Delineation



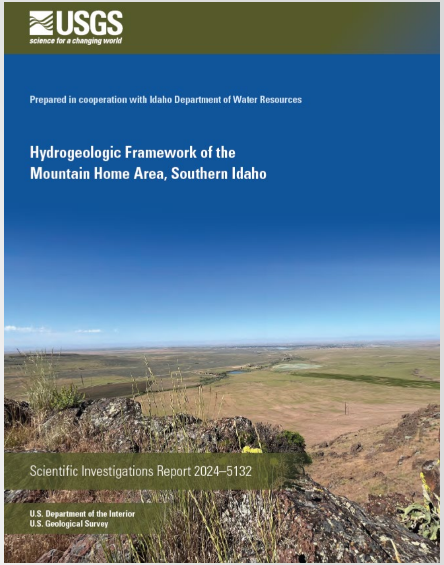


USGS

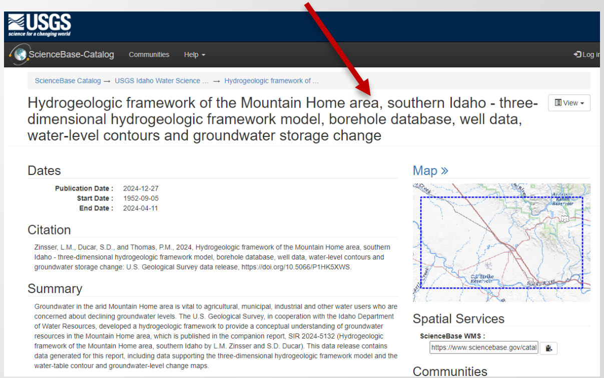
Conclusions

- **Groundwater occurrence:**
  - Main regional aquifer hosted in basalt and fine sediments
  - Perched groundwater zone mainly hosted in basalt
  - Faulting affects groundwater flow (impeding, enhancing)
  - Heterogeneity in basalt creates preferential pathways
- **Groundwater movement:**
  - Regional groundwater flows to the south-southwest
  - Perched groundwater flows west
- **Groundwater change:**
  - Long-term declines in Cinder Cone Butte, south of Mountain Home, MHAFB
  - Surface-water irrigation contributes to recharge in some areas
  - Negative storage change consistent with long-term declines

Read all about it!



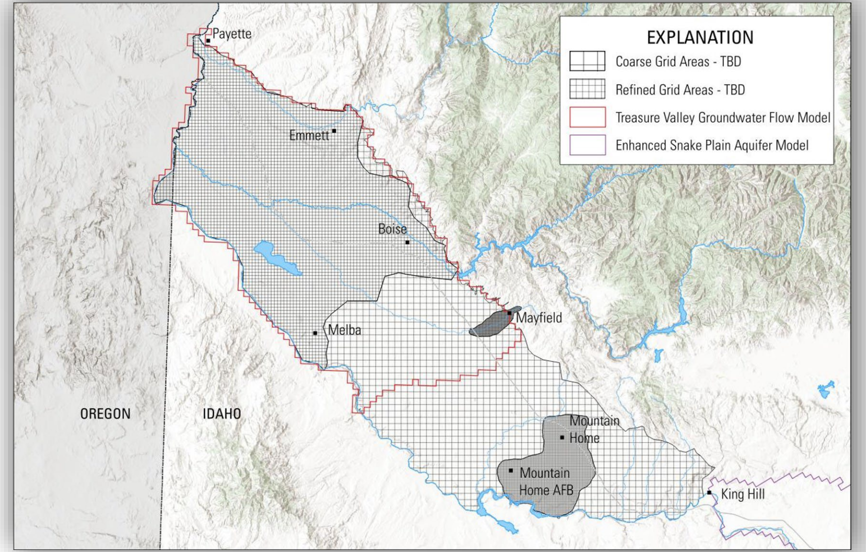
Check out the data!



USGS

Implication for WeSPAM

- **3D hydrogeologic framework model:**
  - Informs the choice of number and thickness of groundwater flow model layers
- **Perched groundwater zone:**
  - Updated the mapped extent of the perched groundwater zone
  - Identified perched groundwater is approximately 50 ft above regional aquifer
  - Provided conceptual description of how water percolates to regional aquifer
- **Groundwater movement and change:**
  - Defined groundwater flow directions across the study area
  - Identified zones of positive and negative groundwater storage change during the 2023 irrigation season
  - Described how faulting can either restrict or enhance groundwater movement



USGS

Questions?

USGS

In cooperation with the
Idaho Department of Water Resources

Lauren Zinsser
lzinsser@usgs.gov

Scott Ducar
sducar@usgs.gov