3-Dimensional Visualization of the Medicine Lake Highland, CA: Topography, Geology, Geophysics, and Hydrology

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We assembled a 3-D database with geologic, geophysical and hydrologic data to allow geoscientists to interpret complex 2D and 3D datasets of an active volcanic region and geothermal prospect, the Medicine Lake Highland in northern California. The images presented herein include geology, gravity (rock density), cultural information and precipitation. The images were created with EarthVision, a software package developed by Dynamic Graphics, Inc.

In Figure 6 and the blue box, we focus on precipitation data and how EarthVision has been used to calculate rainfall inputs to chosen hydrologic basins in the Medicine Lake Highland. After input of isohyetal contours from Rantz (1969) precipitation map of California, we converted the data into a grid of precipitation values (123x162: cell size ~ 1.4 km). By placing the grids over polygons chosen to represent different hydrologic basins, we calculated the volume of rain received in a given region. Such information is important to understanding the hydrologic behavior of the region. In addition, we show how the database can be used to store a variety of geographical and hydrological data (streams, springs, wells, lakes) that can be queried by the user and gridded for a variety of quantitative uses.

This sequence of images shows the identical field area, in northern California. The maps roughly are oriented with north to the top. All represent the western half of the USGS Alturas 250K sheet; ie, the McArthur and Tule Lake 100K sheets. This region is approximately 85 km E to W x 112 km S to N. On the plots, UTM location is shown in meters, so that each labeled increment on the X or Y axis is 10 km. Topography is represented by a digital elevation model (DEM) that has been regridded from an original grid size of ~100m.

1

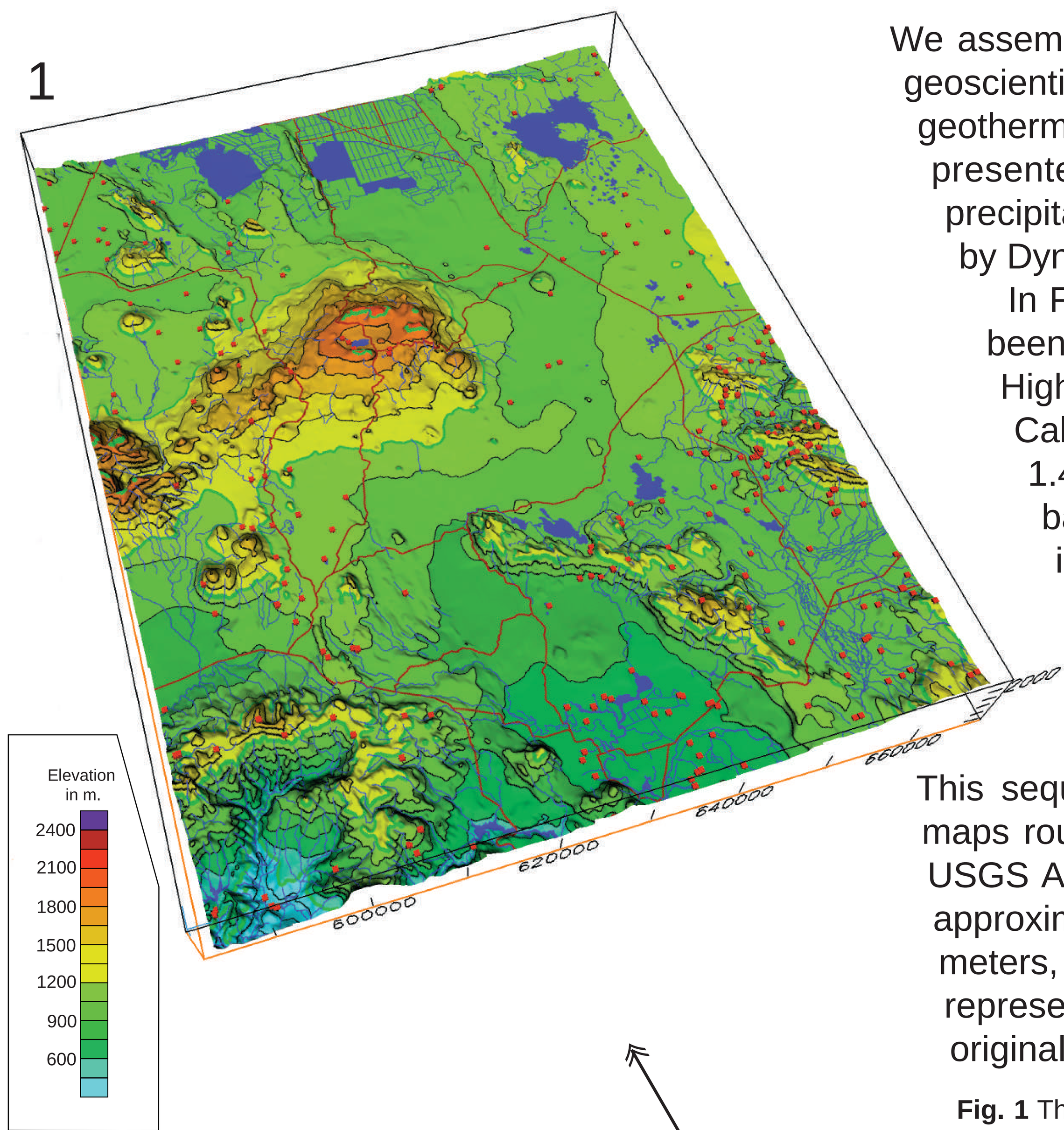

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Fig. 1 This image shows roads (red), springs and wells (red dots), streams and lakes (blue), and 150-m topographic contours (black). The elevation is coded by color. The Medicine Lake Highland, and the areas on its immediate south and east sides are covered with young, porous basalts; therefore, springs and streams are virtually absent.

2

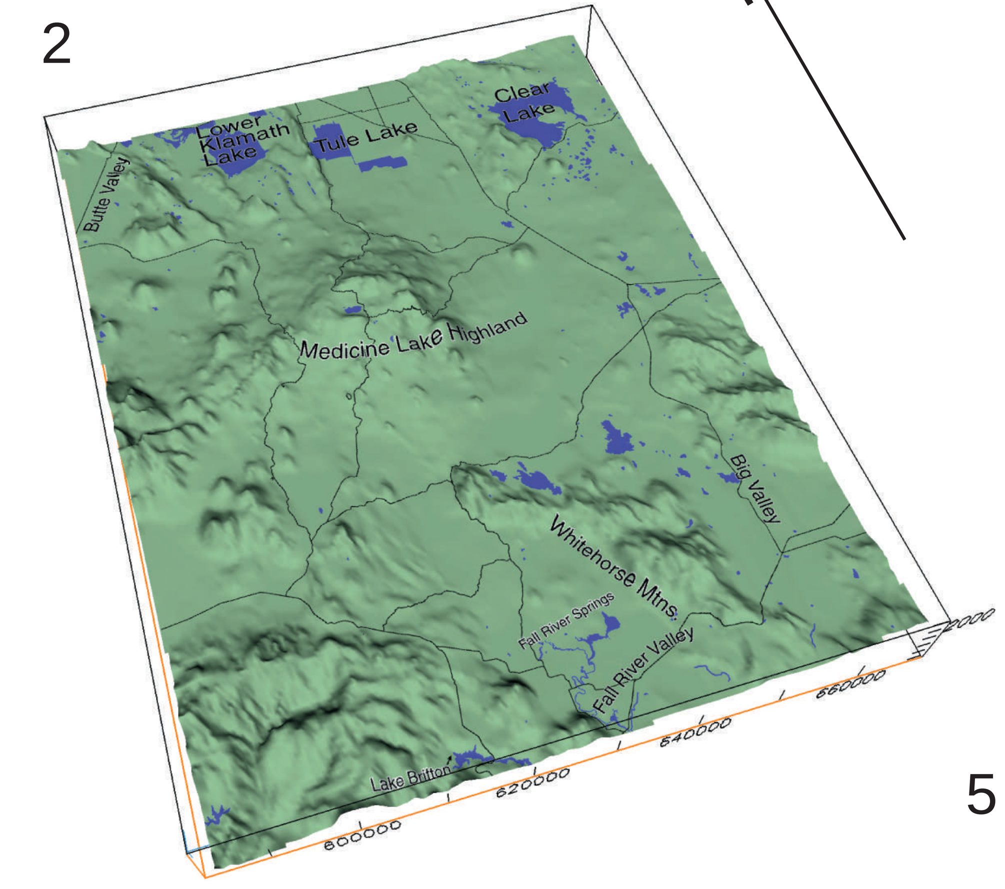


Fig. 2. Key geographic features of the study area.

3

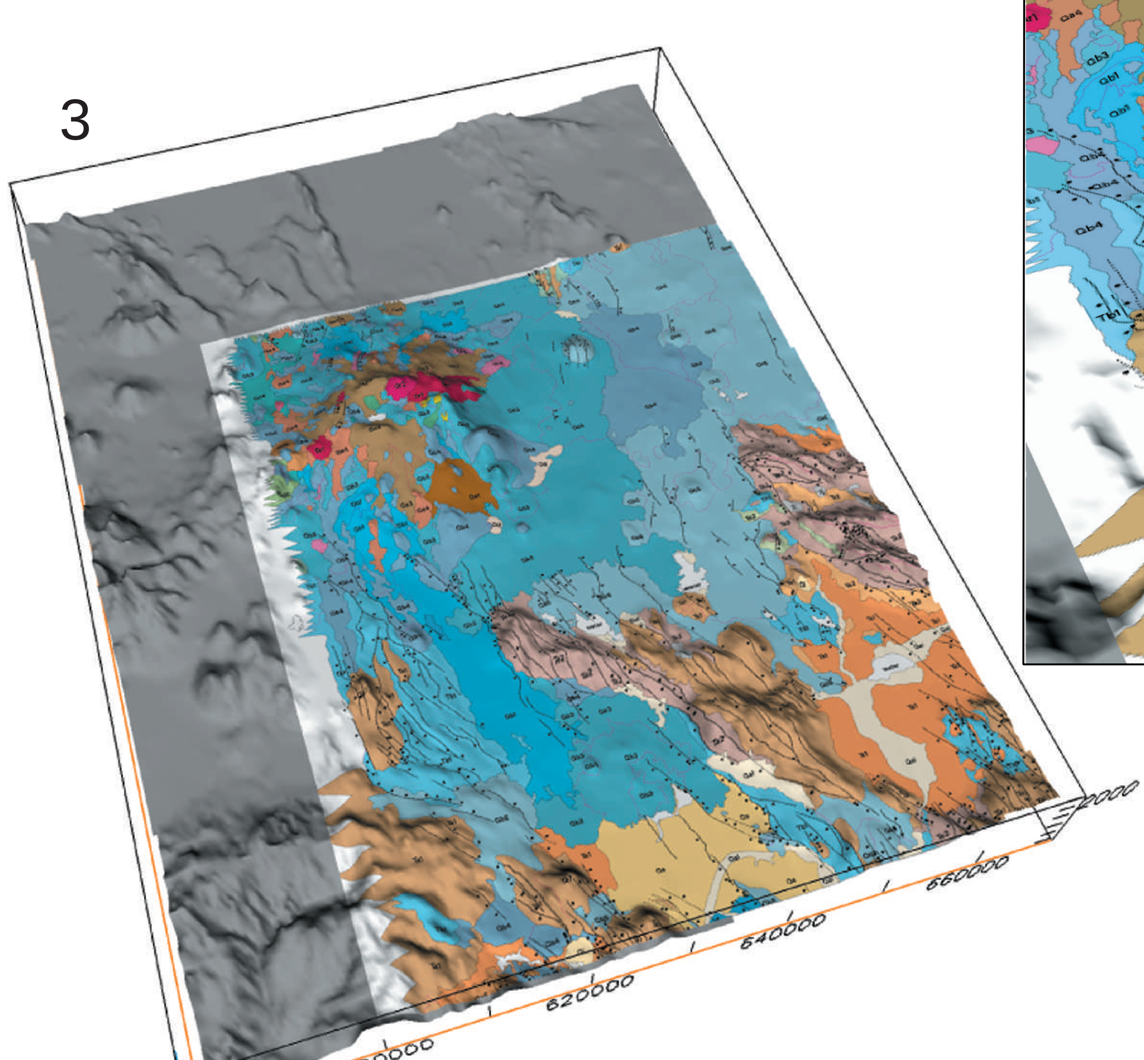


Fig. 3. This map above shows the geologic map of the study area, compiled at 1:250k scale by J.G. Smith, and draped over the DEM. Blues show basalts, browns show andesites, greens are dacites and reds are rhyolites. The ages of the various units are coded by name, with Qb1 younger than Qb2, younger than Qb3, etc. The map region is not fully compiled, so some of the DEM is uncolored.

4

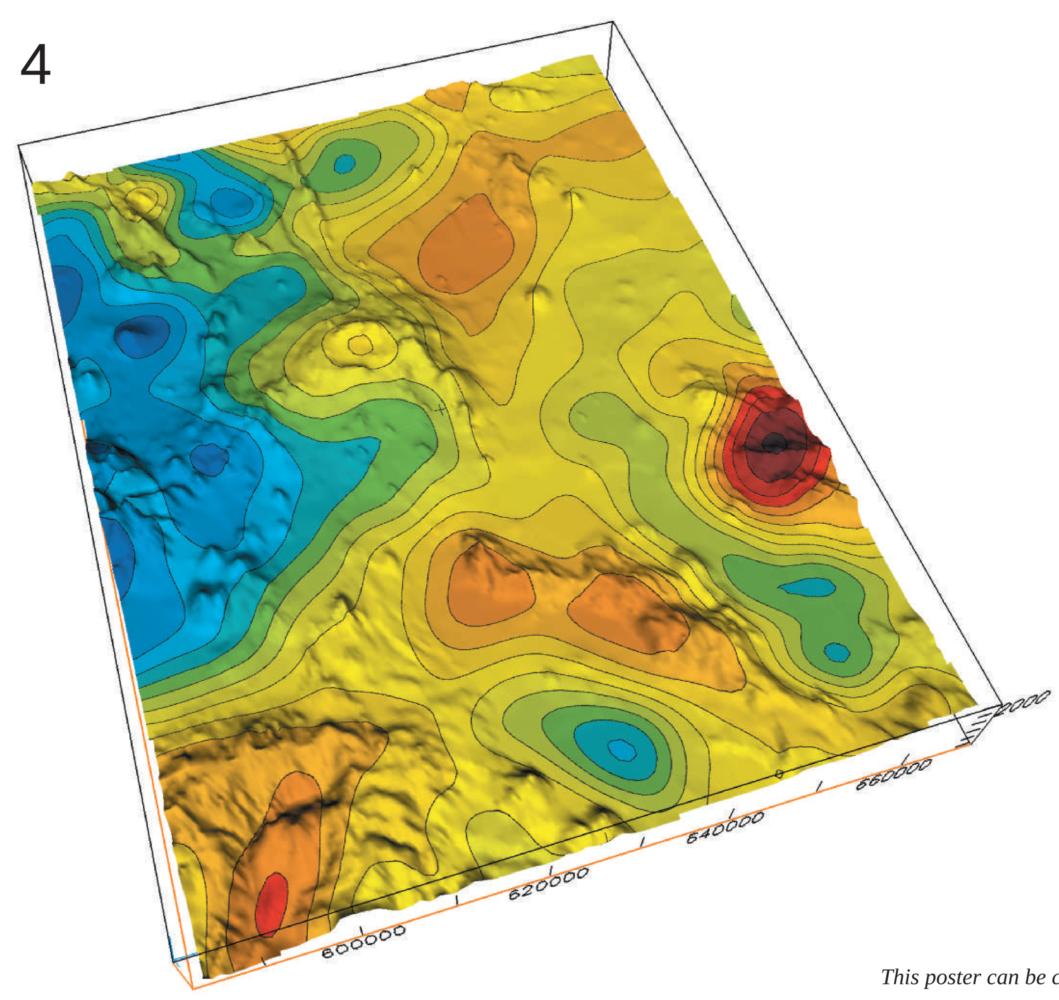


Fig. 4. The color contours superimposed on the DEM represent isostatic residual gravity anomalies of the Medicine Lake Highland and surrounding region. Blues represent gravity lows, underlain by lower density rocks. Reds represent higher density regions. The three sediment-filled valleys (Fall River, Tule Lake and Lower Klamath Lake) have gravity lows due to large amounts of shallow basin-fill sediments. The region between the Medicine Lake Highland and Mt. Shasta is a large gravity low, plausibly because it is warm due to magmatic input. Medicine Lake edifice itself may show a higher gravity signal due to deep, dense, basaltic intrusions (gabbros). The region of the gravity high in the southwest is underlain by Klamath terrain rocks, which may include dense ultramafic materials. The cause of the positive gravity anomaly to the east is unknown.

5

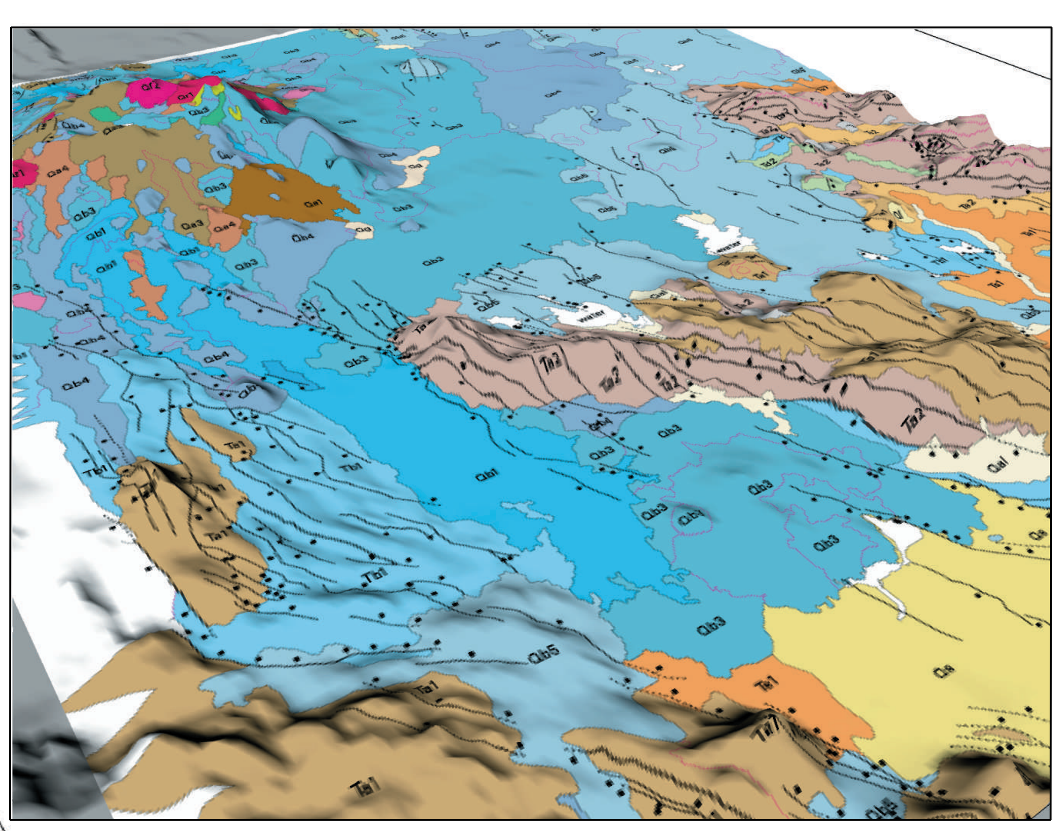


Fig. 5. Close-up of Fig. 3. View is from the southwest over the Fall River Graben (which extends north from the Fall River Valley toward the Medicine Lake Highland) and toward the Whitehorse and Big Valley Mtns, colored in brown. The Medicine Lake highland is in the upper left. The Fall River Springs are located just to the north (left) of the yellow alluvial deposits of the Fall River Valley. The black lines are mappable faults. The single lava flow extending from the Medicine Lake Highland toward the Fall River Valley is the Giant Crater Flow, a ~10,000 year old porous basalt flow which overlies the faults that can be seen in the surrounding older units.

Q= Quaternary, **T**=Tertiary, Browns: Andesites, Blues: Basalts, Reds: Rhyolites, Yellow: Alluvium, White: Lakes

The number indicates relative age, where 1 is the youngest and 5 is the oldest.

6

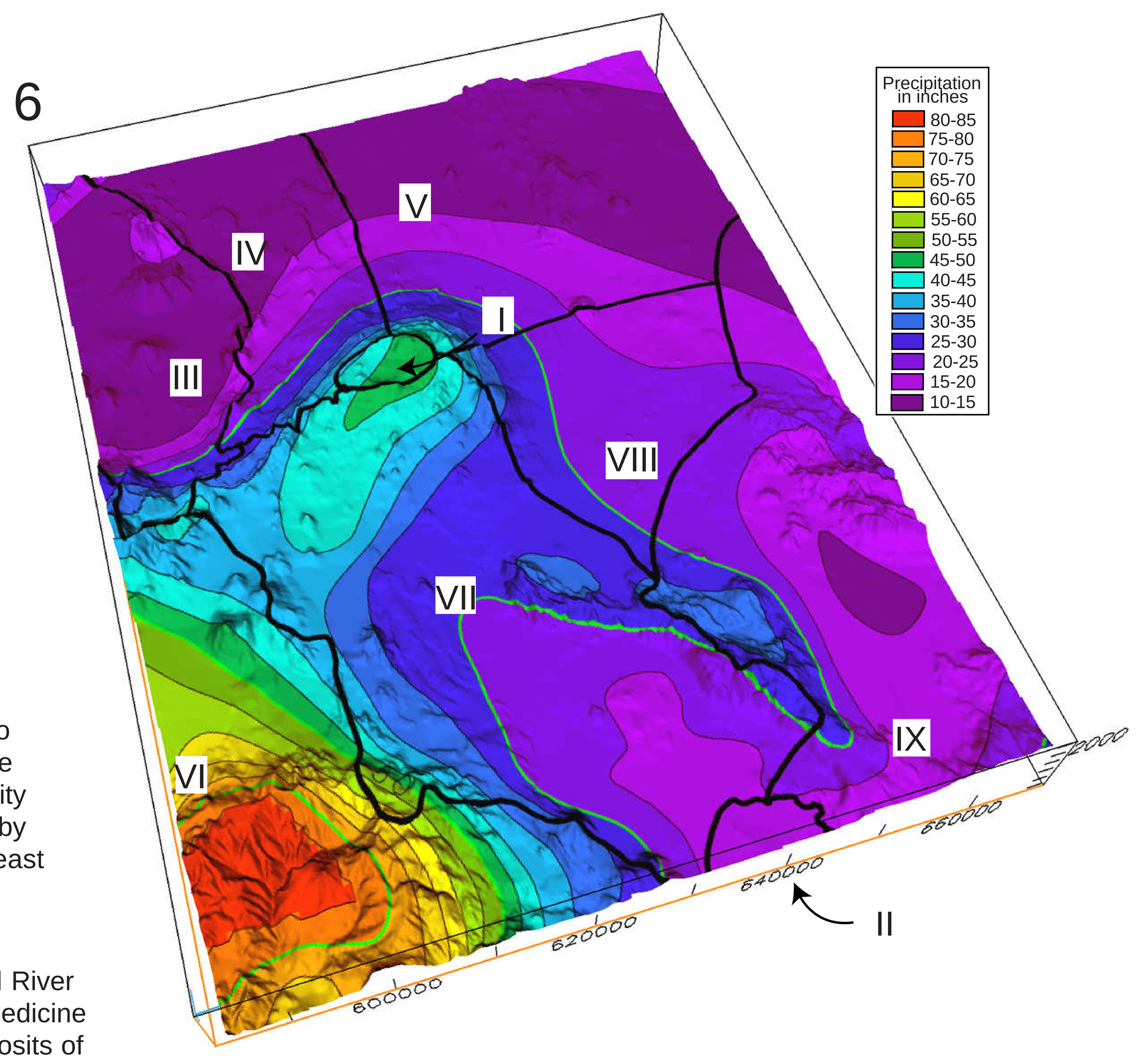


Fig. 6. Precipitation contours from Rantz (1969) Isohyetal map of the state of California. The areas with the highest rainfall are the mountains in the southwest corner followed by the Medicine Lake Highland.

The heavy black lines separate the 9 different hydrologic basins selected for calculation of precipitation input to the region. The basins were chosen partly due to topography, partly because of surface drainages and partly for convenience. In EarthVision, we converted the isohyetal map to a grid and calculated the total precipitation for each hydrologic basin (see blue box).

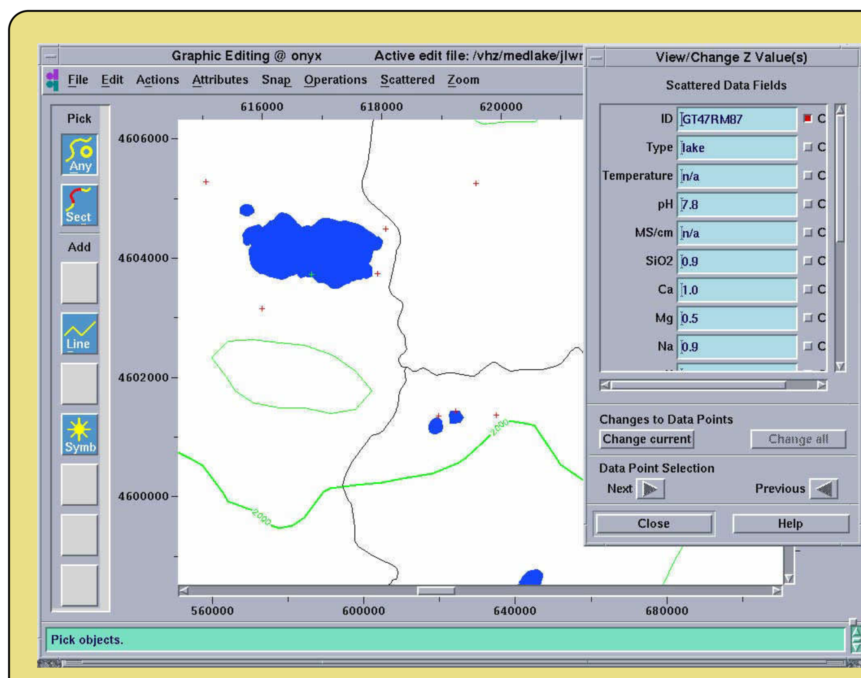
Hydrologic Basin	PRECIPITATION (10^{10} Liters/yr)	Acre-Feet/year
I. Medicine Lake Basin	6.86	55,600
II. S. of Pit River	2.37	19,200
III. Northwest	31.1	252,000
IV. North-central	39.1	317,000
V. Northeast	76.5	620,000
VI. Southwest	172	1,398,000
VII. Fall River Graben	150	1,212,000
VIII. Longbell	44.9	364,000
IX. Southeast	72.8	590,000
Fall River Springs	**107**	**869,000**

Precipitation in the Medicine Lake Highland

Given the geology of the region, the graben faults extending from the Fall River Valley toward the Medicine Lake Highland (Fig. 3), and the porous, lava-tube bearing volcanic flows that extend south from the highland, Basin VII would seem to be the most likely source of recharge to the Fall River Springs. Additional recharge could be supplied by Basins I and VIII, as well as others.

Our calculations show that precipitation input to Basin VII is about 140% of the amount that discharges at the Fall River Springs. Over 70% of this precipitation would have to supply groundwater recharge to be the sole source of water to the springs. This value is quite high, implying that some other basins supply some recharge water.

The Medicine Lake Caldera region (Basin I) receives only 4.5% as much precipitation as Basin VII and 6% of that of the Fall River Springs. Basin I can only be a minor source of water to the Springs.



Individual data points can be queried to provide information on specific sample sites. In this case, the green cross within Medicine Lake has been queried, resulting in creation of a window with sample ID, temperature, pH, chemistry and many other features.

What we plan to do next...

1) Robert Mariner et al. have begun a study of isotopic input of precipitation to Medicine Lake Highland.

2) Determine effect of elevation on isotopic composition of precipitation.

3) Calculate likely isotopic composition of ground and surface waters in any given hydrologic basin.

4) Input data on wells (water chemistry, well depth, isotopic compositions) to better determine possible flow directions and chemical trends.

5) Add relevant lithologic and chemical data from wells to understand the architecture and plumbing beneath Medicine Lake volcano.

You can download a copy of this poster at:
http://caldera.wr.usgs.gov/OF98-777

Acknowledgements

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References: Rantz, S.E. (1969) Mean Annual Precipitation in the California Region: U.S. Geological Survey Basic Data Compilation, Isohyetal map, scale 1:1,000,000, Menlo Park, CA.

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