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Looking Through Loess: Unraveling the Volcanic History at the Transition to the Snake River Plain near Rexburg, Idaho

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Abstract

The southern margin of the Eastern Snake River Plain near Rexburg, Idaho records two mappable periods of basaltic volcanism: a period between the eruptions of the Kilgore Tuff and Huckleberry Ridge Tuff, and a period following the eruption of the Huckleberry Ridge Tuff. The first period includes at least three eruptive events; the second at least seven events. Both periods contain eruptions along rifts that we interpret as extensions of the Grand Valley normal fault. The first detailed maps of the area were created by Embree and Protska in 1978.

On the elevated benches in this area, loess deposits (1 to >10 m thick) cover more than 99 % of the bedrock. As a result, the extent of individual basalt units and their temporal relationships are impossible to determine by field mapping alone. Our attempts to correlate the scattered outcrops using petrography, remanent magnetization, composition, and Ar/Ar ages were mostly inconclusive.

Recently, we have successfully used vertical exaggeration and oriented hillshades of high-resolution digital elevation models to map the extent of individual flow fields, improve flow-vent correlations, and determine relative ages. The improved map relationships have illuminated the volcanic history of the area, including how basalt eruptions have altered drainage patterns.

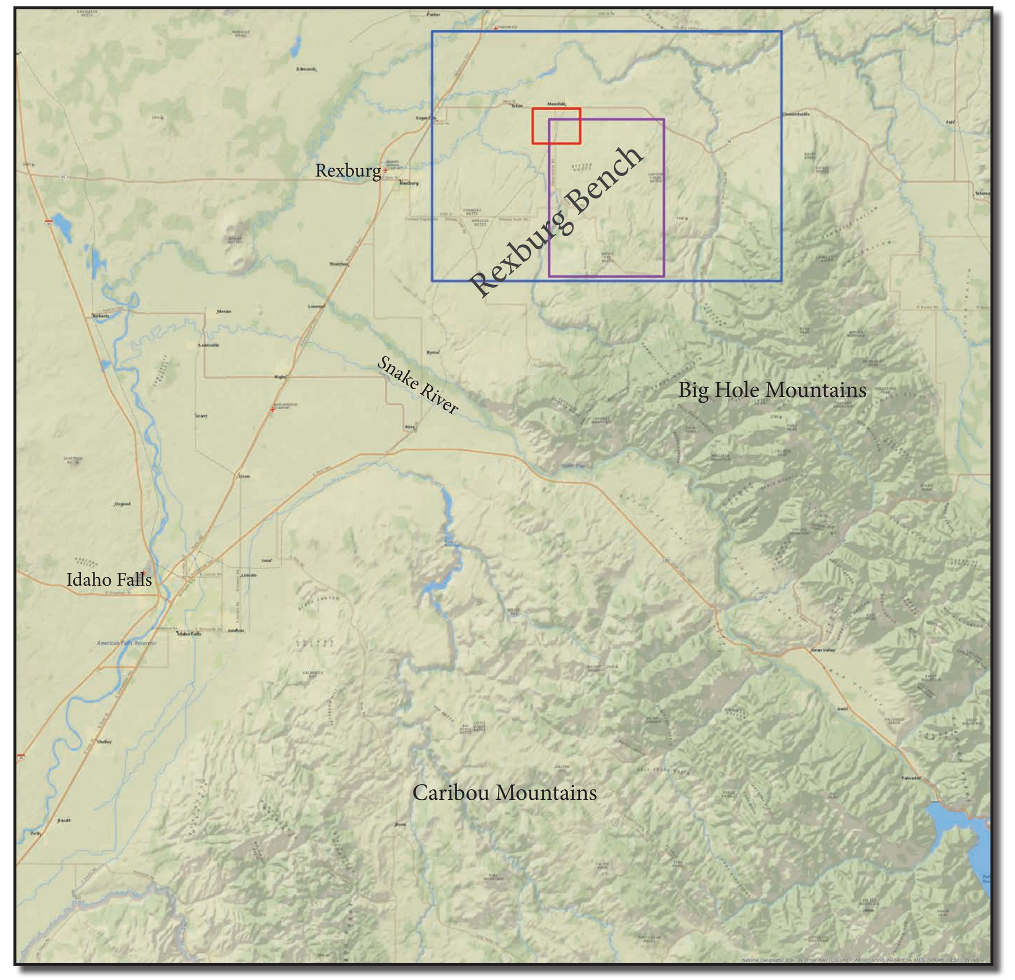

Figure 1. Index map of the Rexburg, Idaho area. Located east of Rexburg, the Rexburg Bench slopes gently to the northwest, from the Big Hole Mountains to the Snake River Plain. It is mostly encompassed by the blue rectangle.
Rectangles are locations of figures. The red rectangle represents the area shown in figures 2 and 5; the purple rectangle is the area shown in figure 3; the blue rectangle is the area shown in figure 6.

The Problem

Loess deposits (1 to >10 m thick) cover more than 99 % of the bedrock on the Rexburg Bench (Figure 1). Early mapping based on petrography of isolated outcrops, well data, topography (Figure 2a), and aerial photography (Figure 2b) did not permit detailed interpretion of the areal distribution and relative ages of individual flow fields. Theses data have the following limitations:

- Unusually-large plagioclase phenocrysts make one unit petrographically distintive. The other units display as much interal variation as they do between units.
- Well data is commonly of little use due to inaccurate well locations and lithologic descriptions.
- The thick loess cover masks original volcanic features on topographic maps (Figure 2a) and air photos (Figure 2b).

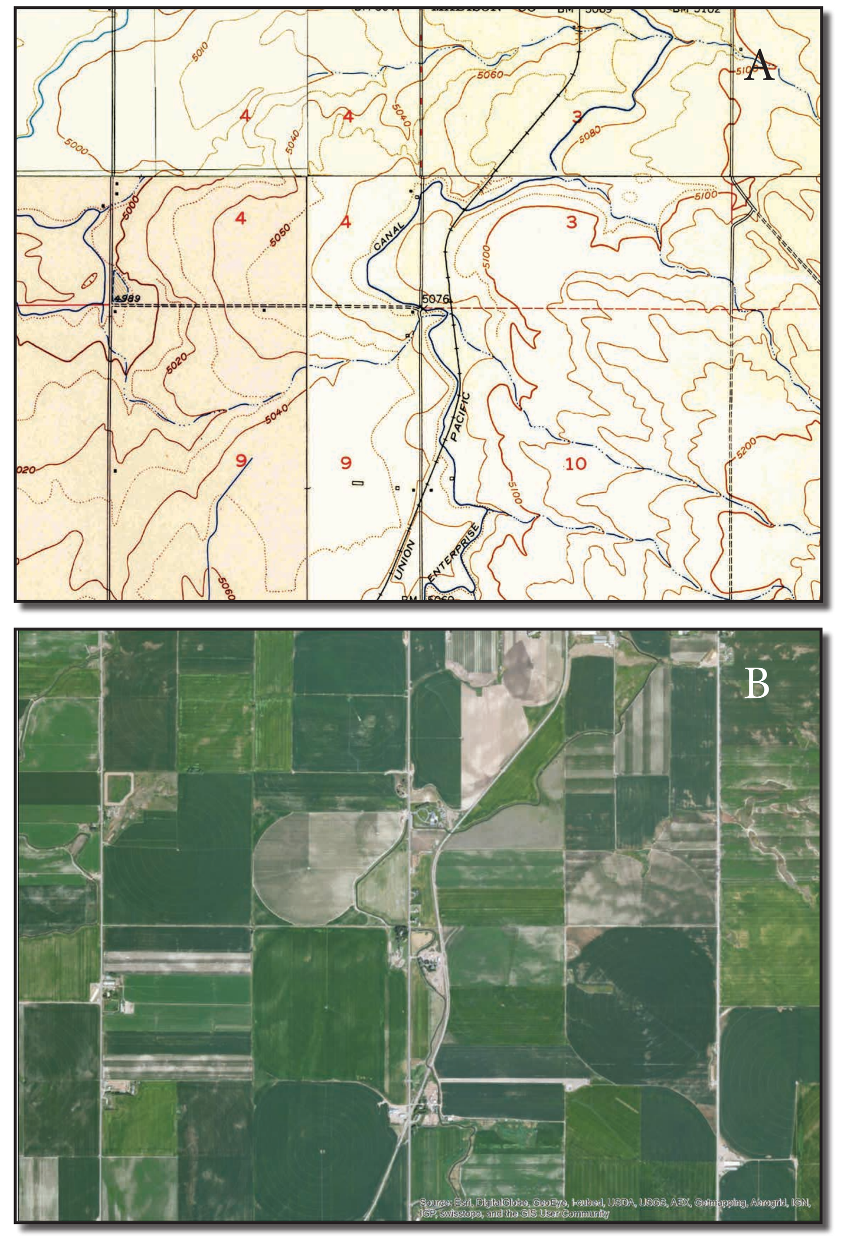

Figure 2. Topographic map (A) and aerial photo (B) illustrate how challenging it is to delineate volcanic features using these tools. These figures cover the area shown by the red rectable in Figure 1.

Initial Interpretation & Next Steps

The original geologic mapping by Embree and Protska was based on small scattered outcrops and subtle topographic clues. The resulting map patterns were imprecise and in many places inaccurate (Figure 3 & 5a).

To improve map quality and determine relative ages, we collected remanent magnetization and chemical data for each unit. With few exceptions, these data failed to improve the mapping or clarify relative ages. The low potassium content of these basalts resulted in Ar-Ar ages with large errors. These ages were of little use.

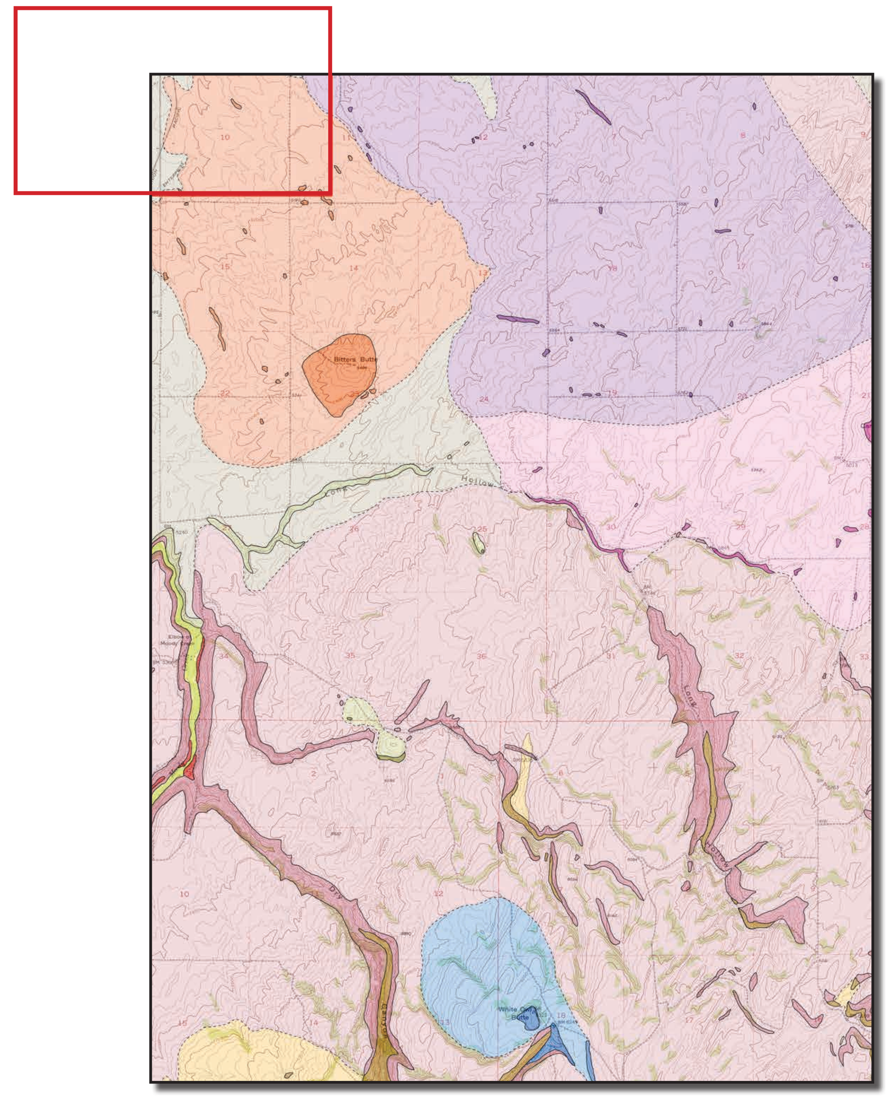

Figure 3. Geologic Map of the Moody, Idaho 7.5 minute quadrangle produced by Embree and Protska in the 1978. Note the small, scattered outcrops in darker colors and the extensive loess-covered areas in lighter colors. The red rectangle represents the area shown in figures 2 and 5.

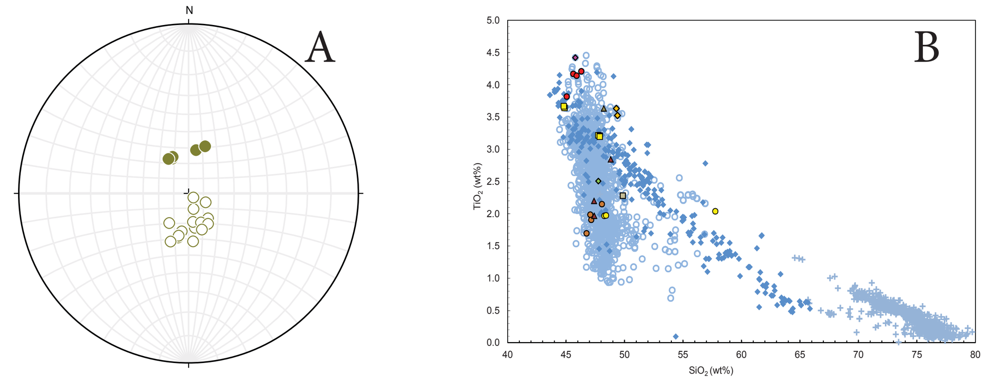

Figure 4. Remanent magnetization (A) and chemical (B) data for Rexburg Bench flow fields. Open circles in **A** have normal polarity; closed circles have reversed polarity. Blue symbols in **B** are from the Snake River Plain, for comparison; other symbols are from the Rexburg Bench. Note that there are few distinctive units.

Solution

High resolution topographic data and digital mapping techniques allowed us to recognize volcanic features concealed by loess cover. We used ArcGIS to manipulate vertical exaggeration and sun angles in ways that helped identify volcanic features, such as vents and the margins, lobes, and surface features of flows (Figure 5b and 5c). The new, detailed flow boundaries allowed us to determine relative ages of flows (Figure 6).

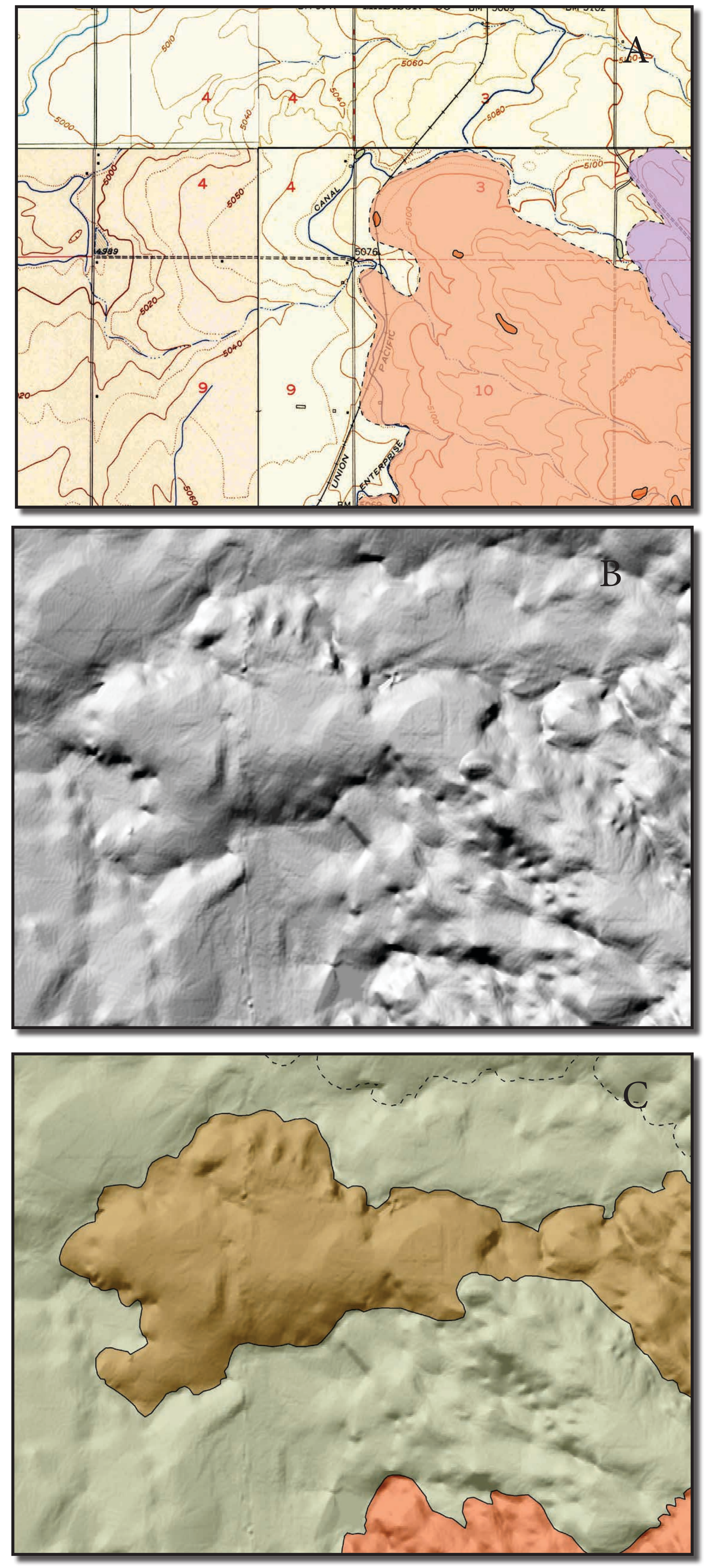

Figure 5. Comparison of old (A) and new (C) mapping of the area outlined in red in figures 1, 3, and 6. **A** is the original mapping on a 7.5 minute topographic base. **B** shows the hillshade map of the same area. **C** is the new map on a hillshade base.

Improved Map

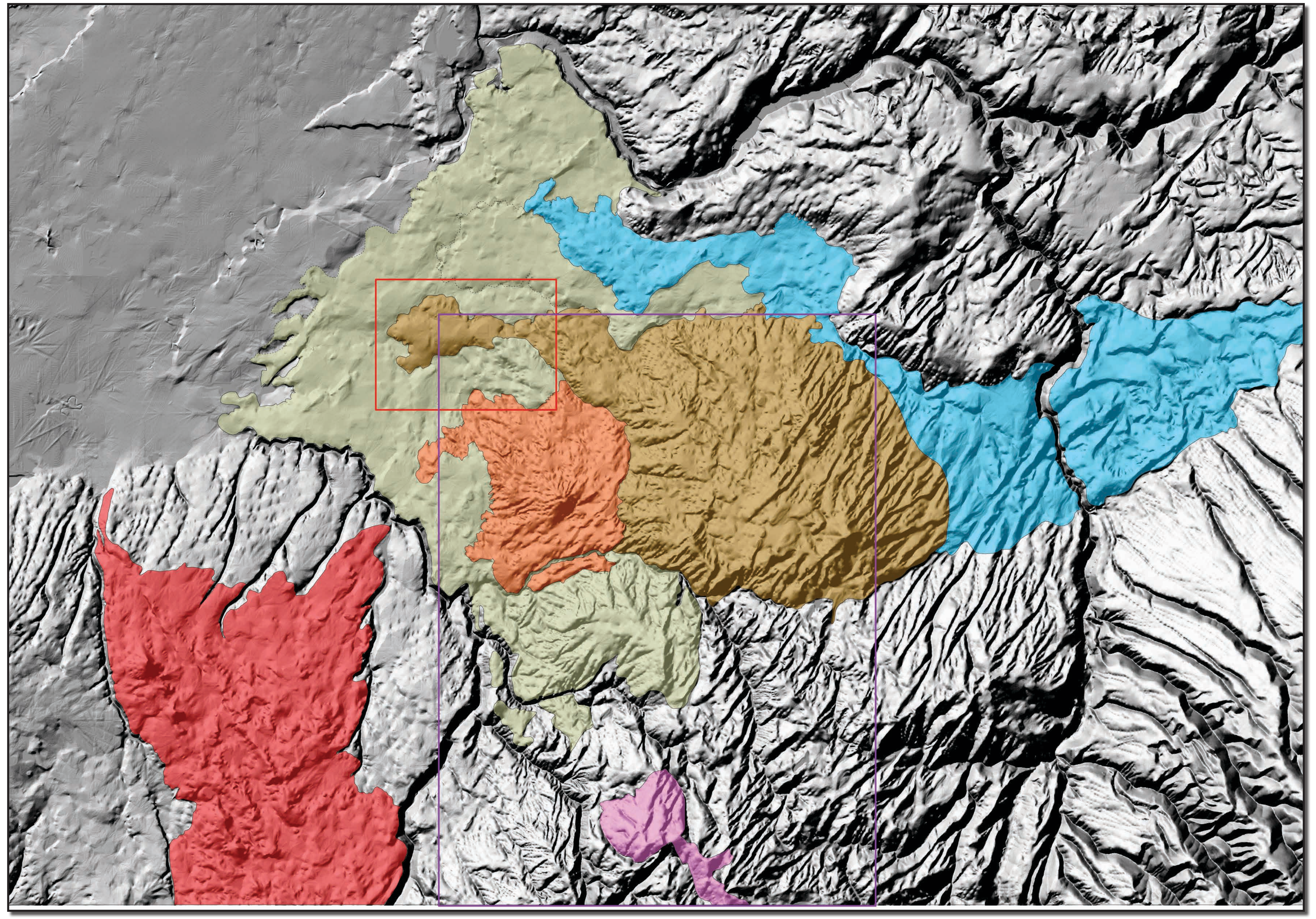

Figure 6. New geologic map on a hillshade base. The map area is defined by the blue box in figure 1. The purple box above is the area shown in figure 3. The red box above is the area shown in figures 2 and 5. Compare the realistic flow-field patterns in this figure to the old mapping in figure 3.

Note the following geologic features (left to right): 1) In the red unit, note the northwest-oriented rift zone and cinder cones. This rift zone appears to be the northern extension of the Basin-and-Range Grand Valley Fault; 2) In the green, orange, brown, and pink units, note the location of vents (topographic highs); 3) Northeast of the pink unit, note the northeast-trending lineations evident in the hillshade. Also, note the relative ages of flow fields (listed oldest to youngest): green unit, orange unit, brown unit, blue unit (sourced to the east). Ar-Ar ages and mostly-uneroded cinder cones indicate that the red unit is youngest.

Conclusion: Varying vertical exaggeration and sun angle on high-resolution digital elevation models can be useful for identifying volcanic features in areas covered by thick loess.