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BOUGUER GRAVITY MAP OF HUALAPAI VALLEY MOHAVE COUNTY, ARIZONA

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Bouguer gravity map of Hualapai Valley, Mohave County, Arizona

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Abstract

A large gravity low of about -40 mGals lies over Hualapai Valley, which is within the transition zone between the Basin and Range province and the Colorado Plateau in northwestern Arizona. The low represents a bedrock depression containing several thousand feet of Cenozoic sedimentary and volcanic rocks, and deposits of halite and other evaporites. Data indicate that a salt body, as much as 8 km (5 mi) wide and 1830 m (6000 ft) thick lies below 460 m (1500 ft) of sediment in the center of the valley. The gravity data suggest that the salt extends over a distance of 19 km (12 mi).

Introduction

Hualapai Valley lies between the Cerbat Mountains and the Grand Wash Cliffs northeast of Kingman in the central part of Mohave County, Arizona. The main part of the valley, shown in figure 1, trends northwestward and is terminated on the north by the White Hills and Grapevine Mesa. It is an area of closed surface drainage that comprises about 1200 km^2 (462 sq. mi) and lies mostly below 914 m (3000 ft) elevation. The principal stream, Truxton Wash, drains into the playa at Red Lake, which occupies about 60 km^2 (22 sq mi) in the northern part of the valley floor.

The Cerbat Mountains on the west rise abruptly to elevations above 1830 m (6000 ft). The highest mountain peaks, Mount Tipton in the northern part and Cherum Peak in the central part, are 2135 m (7000 ft) above sea level. On the east, the Grand Wash Cliffs are the front of an extensive upland that rises to elevations above 1525 m (5000 ft). Garnet Mountain and Iron Mountain attain heights near 1950 m (6400 ft). Crestal altitudes of the Music Mountains to the southeast range from 1830 to 2040 m (6000 to 6700 ft). Elevations of 1220 m (4000 ft) to more than 1525 m (5000 ft) occur in the White Hills and on Grapevine Mesa.

Geology

The region is underlain by igneous, metamorphic, and sedimentary rocks ranging in age from Precambrian to Holocene. Quartz-mica and chloritic schists, amphibolites, and quartzose gneisses make up most of the older Precambrian metamorphic complex. These rocks have been folded and faulted and intruded by granitic and other igneous rock masses of Precambrian and later age. The igneous and metamorphic rocks are fairly well exposed in the uplands, but in places they are covered by Paleozoic sedimentary rocks and younger volcanic rocks. Thick deposits of late Tertiary and Quaternary alluvium cover most of the bedrock floor of the valley.

The valley lies in the transition zone between the physiographic Basin and Range province and the Colorado Plateau. The Cerbat Mountains on the west and Peacock Mountains in the south of the valley are tilted fault blocks and their strata dip 10°-20°E (Gillespie and Bentley, 1971, p. H9-H12). Paleozoic rocks on the Grand Wash Cliffs dip eastward. Very likely, the bedrock floor of the valley, consisting of Precambrian igneous and metamorphic rocks with some overlying Paleozoic strata and Tertiary volcanic rocks, also dips to the east. Normal faults lie along the west front of the Cerbat Mountains and the Grand Wash Cliffs. Precambrian rocks exposed near Lone Mountain and the north end of the Peacock Mountains appear to restrict the southern part of the valley.

Hualapai Valley is an intermontane basin that is several thousand feet deep and contains alluvium, volcanic rocks, and evaporites (Gillespie and Bentley, 1971, p. H12-H15). The alluvial deposits consist of moderately to weakly consolidated fragments of the basement complex, volcanic rocks, fine gravel, sand and silt of Tertiary and Pleistocene age; and unconsolidated clastic rock fragments, silt and clay of late Pleistocene age. Underlying and interbedded with the Tertiary alluvium locally are basalt, andesite flows and tuff. Evaporites occur in the subsurface near Red Lake (Gillespie and Bentley, 1971, p. H13). Three test holes drilled a few miles southeast of the lake found a deposit of halite more than 1220 m (4000 ft) thick lying beneath alluvium and bedded anhydrite and gypsum. The top of the halite body lies about 460 m (1500 ft) below the valley surface. The holes bottomed in salt at depths of 650, 795, and 1827 m (2135, 2608, and 5994 ft).

Rock densities

Density determinations made from 24 surface samples of well-cemented Precambrian and Paleozoic rocks indicate that the densities of the metamorphic rocks range from 2.5 to 3.0 g/cm^3, with an average density of 2.7 g/cm^3, and that densities of the sedimentary rocks range from 2.3 to 2.8 g/cm^3, and average about 2.6 g/cm^3. Measured densities of 8 samples of the granitic rocks range from 2.5 to 2.7 g/cm^3. Densities of 10 samples of the Tertiary volcanic rocks range from 2.1 to 2.4 g/cm^3 for tuff and from 2.4 to 2.7 g/cm^3 for basalt.

No density measurements were made of the Tertiary and Quaternary deposits in the valley. The average density of these materials, suggested by descriptions given in publications and logs of drill holes, is estimated to be about 2.2 g/cm^3.

Gravity data

Gravity measurements were made at 245 stations--mainly bench marks and other points of known elevation established by the U.S. Geological Survey, U.S. Coast and Geodetic Survey (U.S.C.&G.S.), and U.S. Bureau of Reclamation. A LaCoste and Romberg gravity meter was used and the observed gravity was referenced to a value of 979,468.52 mGals at U.S.C.&G.S.Bench Mark M-254 in Dolan Springs, Arizona. The data were corrected for drift, elevation, latitude, and effects of terrain within 12 km (7.5 mi) of each station. An elevation factor of 0.06 mGal per foot, based on an assumed density of 2.67 g/cm^3, was used in computing elevation and terrain corrections.

Figure 1 shows a major gravity low of about -40 mGals that lies over the valley floor. The minimum gravity value is centered near drill holes about 5 km (3 mi) southeast of Red Lake. Extending northwest from the minimum is a narrow region of anomaly of much smaller amplitude with a minimum at the Pierce Ferry Road. To the west, a small negative closure in the -135 mGal contour lies near Cyclopic (site). Steep gravity gradients lie along the northeast and southwest flanks of the major low and undulations in contours seem to mark the exposed bedrock front along the valley margin.

Interpretation

The gravity low is interpreted to be caused by a large bedrock depression filled with Cenozoic sedimentary deposits, interbedded low-density volcanic rocks, and deposits of halite and other evaporites. Precambrian igneous and metamorphic rocks with some overlying Paleozoic strata of low density are inferred to comprise the bedrock floor of the depression. Two-dimensional model studies indicate that beneath the central part of the valley, which is about 18 km (11 mi) wide, the bedrock floor dips generally northeastward and may lie as much as 2740 to 3050 m (9,000 to 10,000 ft) below the surface. Steep slopes that were probably formed by faulting lie along the northeast side of the basin floor. Step-faults in a broad fault zone may occur along the southwest side. Southeastward the basin diminishes slightly in width and tends to shallow out near Lone Mountain and along the front of the Peacock Mountains. Northwestward the basin narrows to a width of 8 km (5 mi) and its floor rises to depths of a few thousand feet north of Red Lake. Continuing northwestward the bedrock forms a slightly deeper appended part of the depression, which appears to terminate just north of the Burnt Mill Ranch.

The size and shape of the halite deposit that occupies a large part of the basin fill is difficult to determine. Results of drilling indicate that (1) the salt mass lies about 460 m (1500 ft) below the surface; (2) the deposit is more than 1220 m (4000 ft) thick; and (3) it has a maximum width greater than 5 km (3 mi). Gravity data indicate that the salt body lies in the center of the valley and is nearly parallel to the axis of the inferred depression. Very likely the minimum gravity values occur over the thickest part of the deposit. Assuming that the deposit is tabular in shape and of non-marine origin, interpretation of the gravity profile across the valley (fig. 2) by two-dimensional modeling indicates that the salt mass may be as much as 8 km (5 mi) wide and 1830 m (6000 ft) thick. Amplitude and trend of the anomaly suggests that the salt accumulated over a distance of 19 km (12 mi) along the center of the valley. However, the interpretation of gravity data cannot be made with a high degree of confidence, because that part of the anomaly caused by the salt is not defined and the density contrasts in the basin fill and underlying bedrock are unknown.

The small gravity low across the Pierce Ferry Road is attributed to alluvium and salt in the appended shallow part of the depression. Refraction

EXPLANATION

QTal	Quaternary and Tertiary alluvium and unconsolidated sediments
Tv	Tertiary volcanic rocks
pTs	Pre-Tertiary sedimentary rocks
p€m	Precambrian granitic and metamorphic rocks

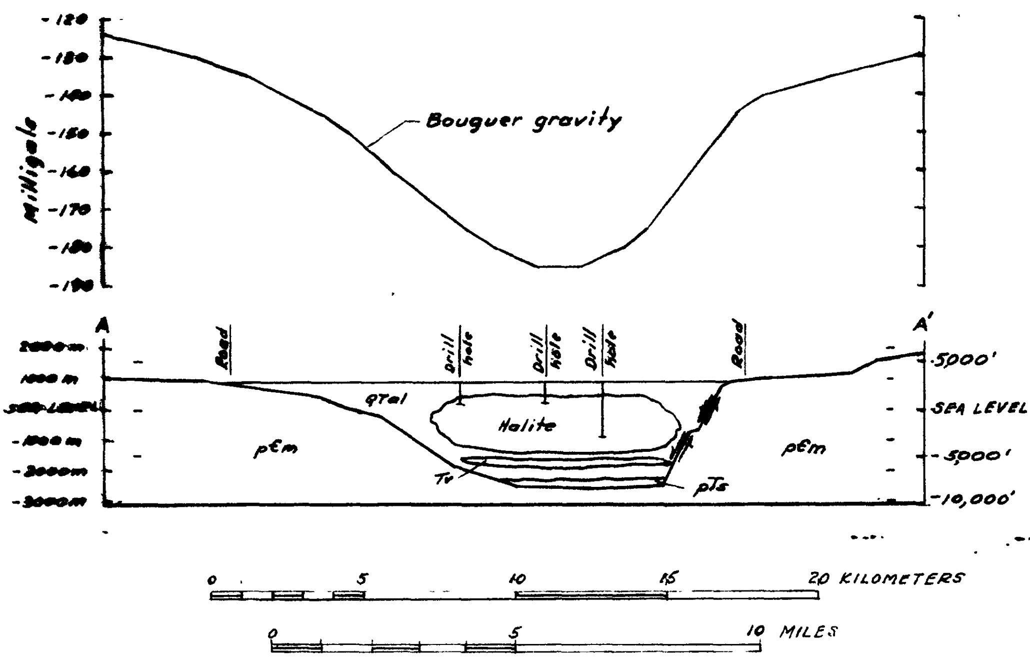

FIGURE 2. Section A-A' showing interpretation of gravity profile.

seismic measurements along the road across the gravity minimum revealed layer discontinuities and velocities of 3.65 to 4.85 km/s (12,000 to 15,900 ft/s) between estimated depths of 180 m (600 ft) and 910 m (3000 ft) (Gillespie and Bentley, 1971, p. H15). The velocities greater than 4.57 km/s (15,000 ft/s) probably represent salt as suggested by the low gravity values. The deposit is considered to be small and probably lies below a depth of 460 m (1500 ft).

The small amplitude negative closure to the west correlates with a high-gradient positive magnetic anomaly (U.S. Geol. Survey, 1972) and suggests the presence of a low-density magnetic granitic intrusion in the shallow subsurface.

References cited

Gillespie, J. B. and Bentley, C. B., 1971, Geohydrology of Hualapai and Sacramento Valleys, Mohave County, Arizona, USGS Water-Supply Paper 1899-H, 37 p.

U.S. Geological Survey, 1972, Aeromagnetic map of the Gold Butte-Chloride area, Arizona and Nevada, Geophys. Inv. Map GP-757 (2 sheets), scale 1:62,500.