U.S. DEPARTMENT OF THE INTERIOR

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GRAVITY MODELS OF ABBY CREEK AND BION BARITE DEPOSITS, HOWARD PASS QUADRANGLE, NORTHWESTERN BROOKS RANGE, ALASKA

by

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INTRODUCTION

Gravity surveys were made in 1991 over two barite deposits described by Kelley and others (1993). These bodies have been named the Abby Creek deposit and the Bion deposit. The purpose of these surveys was to determine the subsurface shapes and lateral extent of these bodies beyond the barite exposed at the surface. Barite is a very dense mineral with a specific gravity of about 4.48 g/cm^3 for pure barite. The samples collected from outcrop at these locations have an average specific gravity of 4.27 g/cm^3, making them nearly pure. These dense barite deposits are well suited for density modeling because of their large density contrasts with average crustal rock which has a density of 2.67 g/cm^3. These deposits are located in the Cutaway Creek drainage north of Mount Bupto on the Howard Pass (C-3) 1:63,360 quadrangle in the northwestern Brooks Range of Alaska. This area is informally referred to as Cutaway basin.

GEOLOGIC SETTING

Abby Creek and Bion high-grade stratiform barite deposits are found in rhythmically bedded radiolarian chert of Carboniferous age. The host rocks of these barite deposits are located in poorly exposed and complexly folded imbricate thrust sheets which are composed of rocks which range in age from Mississipian to Early Cretaceous and underlie the southern Arctic foothills adjacent to the northwestern Brooks Range. The thrust sheets which contain these deposits are part of the Brooks Range fold and thrust belt which is a system of folds and north-directed thrust faults underlying the Arctic foothills and the Brooks Range, and span northern Alaska.

GRAVITY SURVEYS

High-precision gravity surveys were conducted using a La Coste and Romberg G-model gravity meter. Horizontal and vertical control were established with a precision laser surveying instrument. Precise control for the study areas in the form of bench marks were not available. The locations for the starting points of the surveys were either located on topographic maps in the case of the Abby Creek deposit or by resection in the case of the Bion deposit. In both surveys, the base elevation was estimated from topographic maps. By using a laser surveying instrument, locations relative to the local base were established to within 0.001 minutes of latitude and longitude and relative elevations were established to within 0.1 m. Elevations were measured more precisely than 0.1 m, but tundra cover over much of the study areas made surface measurements difficult.

Observed gravity values of local gravity bases at each barite deposit were calculated based on ties to gravity base station FBKI (Barnes, 1968) at Fairbanks International Airport. The gravity data were reduced with a density of 2.67 g/cm^3, on the IGSN-1971 datum (Morelli, 1974), and using the 1967 ellipsoid (International Association of Geodesy, 1971). Observed gravity values of data points along profiles are accurate to about 0.03 mGal relative to the local base station. Additional corrections were made for elevation, terrain, earth tides, and drift between successive base readings. Complete Bouguer anomalies are accurate to about 0.08 mGal relative to the local base station. Gravity maps of Abby Creek (fig. 1) and Bion (fig. 2) are contoured with an interval of 0.1 mGal. The data point values were gridded based on the principle of minimum curvature (Briggs 1974). Shaded areas on the maps represent exposed barite. The gravity profiles were continued beyond the exposed barite outcrops until the field gravity readings leveled out, indicating that the effect of the barite bodies were no longer influencing the gravity fields and the measurements are showing only the effect of the regional gravity field.

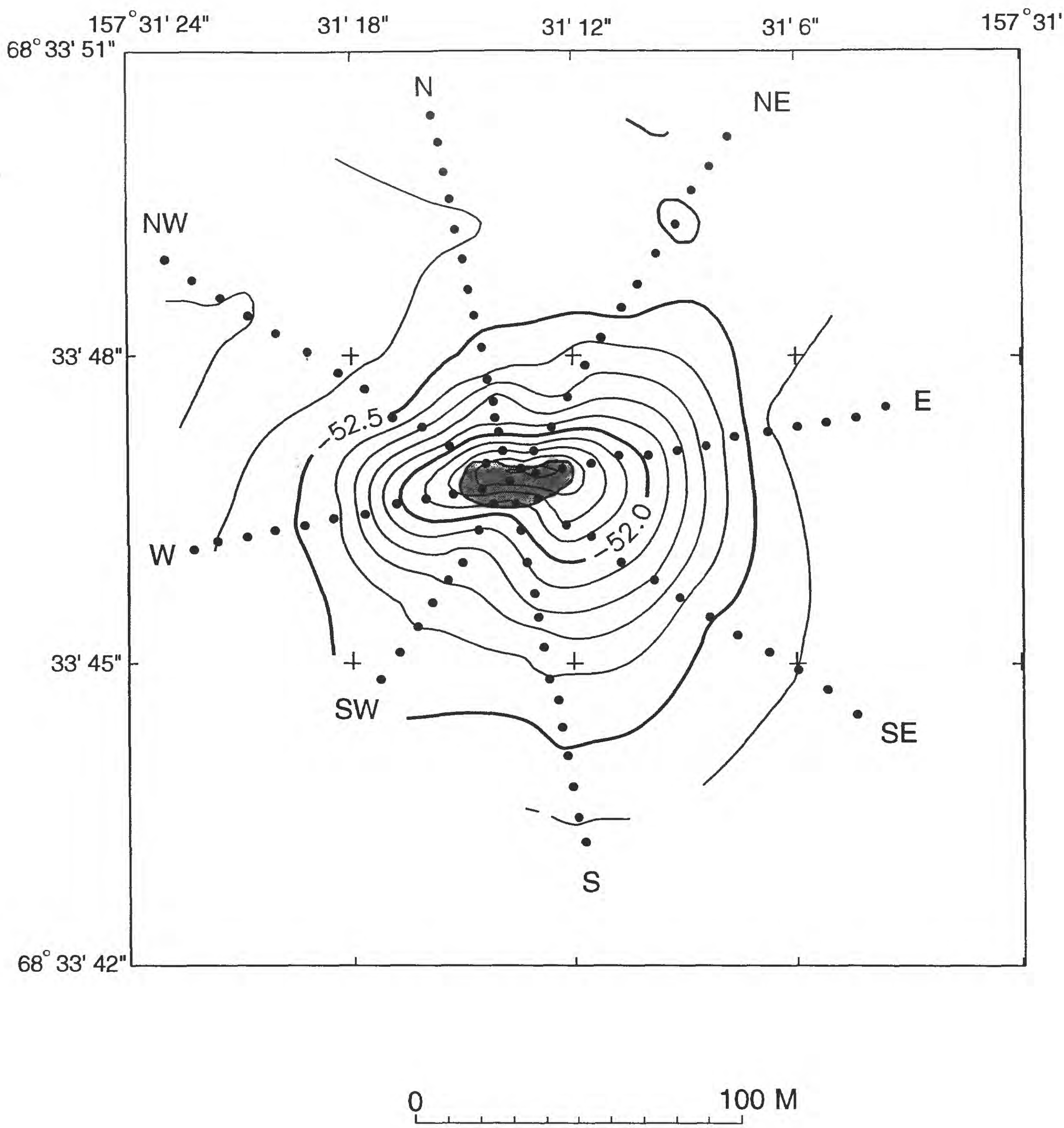

FIGURE 1. Complete Bouguer gravity map in the vicinity of the Abby Creek barite deposit. Contour interval 0.1 mGal. Filled circles are gravity stations. Shaded area is exposed barite. Letters at each end of the gravity profiles refer to the names of the gravity model profiles.

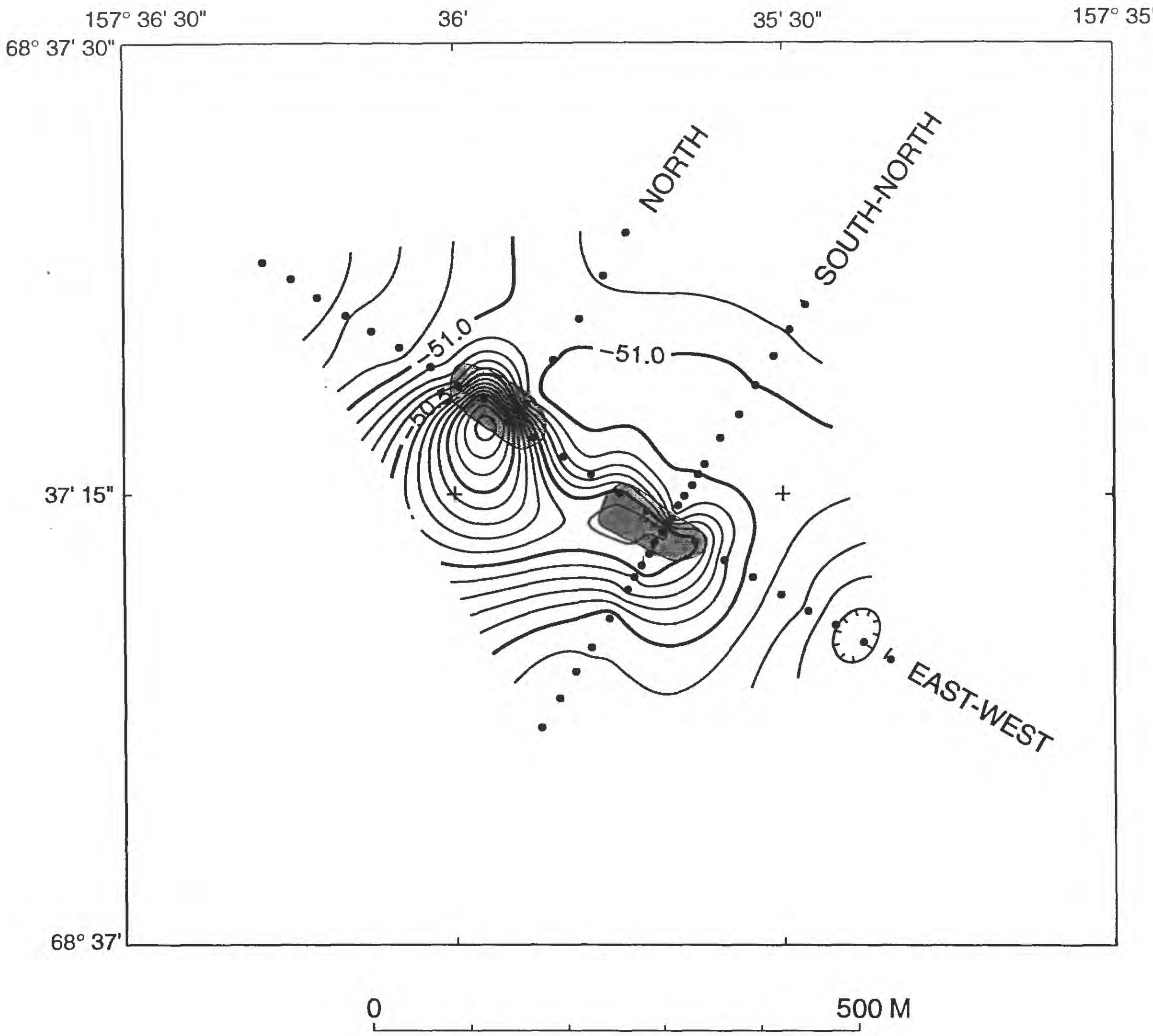

FIGURE 2. Complete Bouguer gravity map in the vicinity of the Bion barite deposit. Contour interval 0.1 mGal. Filled circles are gravity stations. Shaded area is exposed barite. Labels at the end of the gravity profiles refer to the names of the gravity model profiles.

GRAVITY MODELS

Gravity modeling was conducted using an interactive forward modeling program of Saltus and Blakely (1993). Gravity and topographic values used in the modeling were extracted from a grid derived from the reduced gravity data. Specific gravity of the barite, based on an average of 37 samples from both deposits, is 4.27 g/cm^3, thus a density contrast of 1.6 relative to 2.67 g/cm^3 for average crustal rock was used for modeling. The gravity models (figs. 3-9) are based on a 2 1/2-dimensional body with perpendicular extents of the bodies based on the gravity anomalies associated with each profile. A 2-dimensional body is one that continues infinitely in both directions from the plane of the body whereas a 2 1/2-dimensional body has finite distances perpendicular to the plane of the body. These distances can be set individually and allows for a more precise shape of a body. The ends of the bodies are planner and parallel to the cross-section. The cross-section is what is displayed in the models.

The gravity models show possible shapes of nearly pure barite deposits below the surface. Bodies containing significant amounts of host rock would be given a smaller density contrast and would result in larger bodies to match the observed gravity anomalies. Surface observations indicate that the barite body at Abby Creek is dipping to the south whereas the barite body at Bion is dipping to the southwest. This influenced the initial shape of the bodies in the models, but was confirmed after modeling began. Dips without a southern component for Abby Creek or southwest component for Bion are not possible based on the gravity anomalies of these barite bodies. However, measured dips at the outcrops do not agree with the modeled dips at depth. This problem was not resolved. Certainly other shapes are possible and further modeling is needed to incorporate other theoretical structural models. These models show the mass and general shape of barite bodies of uniform composition needed to cause the associated gravity anomalies.

These models are shown as continuous bodies without any internal structure. It is quite possible, however, that significant folding and thrusting have occurred to these bodies. The models do show that there are no significant barite bodies within these small study areas other than deposits directly associated with the outcropping bodies. Small outliers of barite rubble were observed at both Abby Creek and Bion barite deposits, but gravity measurements did not detect any massive bodies at the locations of theses outliers.

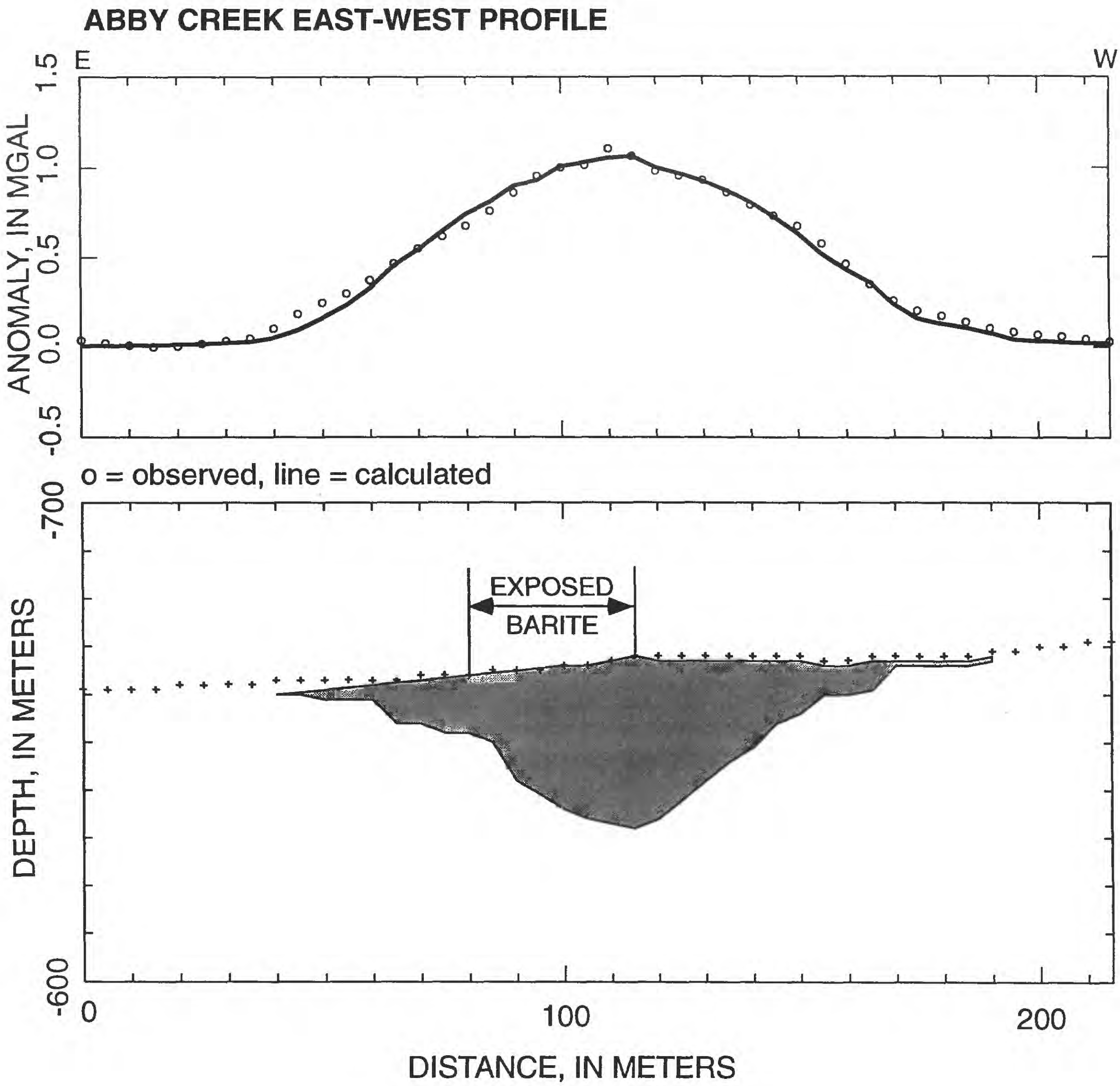

Figure 3. Gravity model across the Abby Creek barite deposit. Profile goes from east to west. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

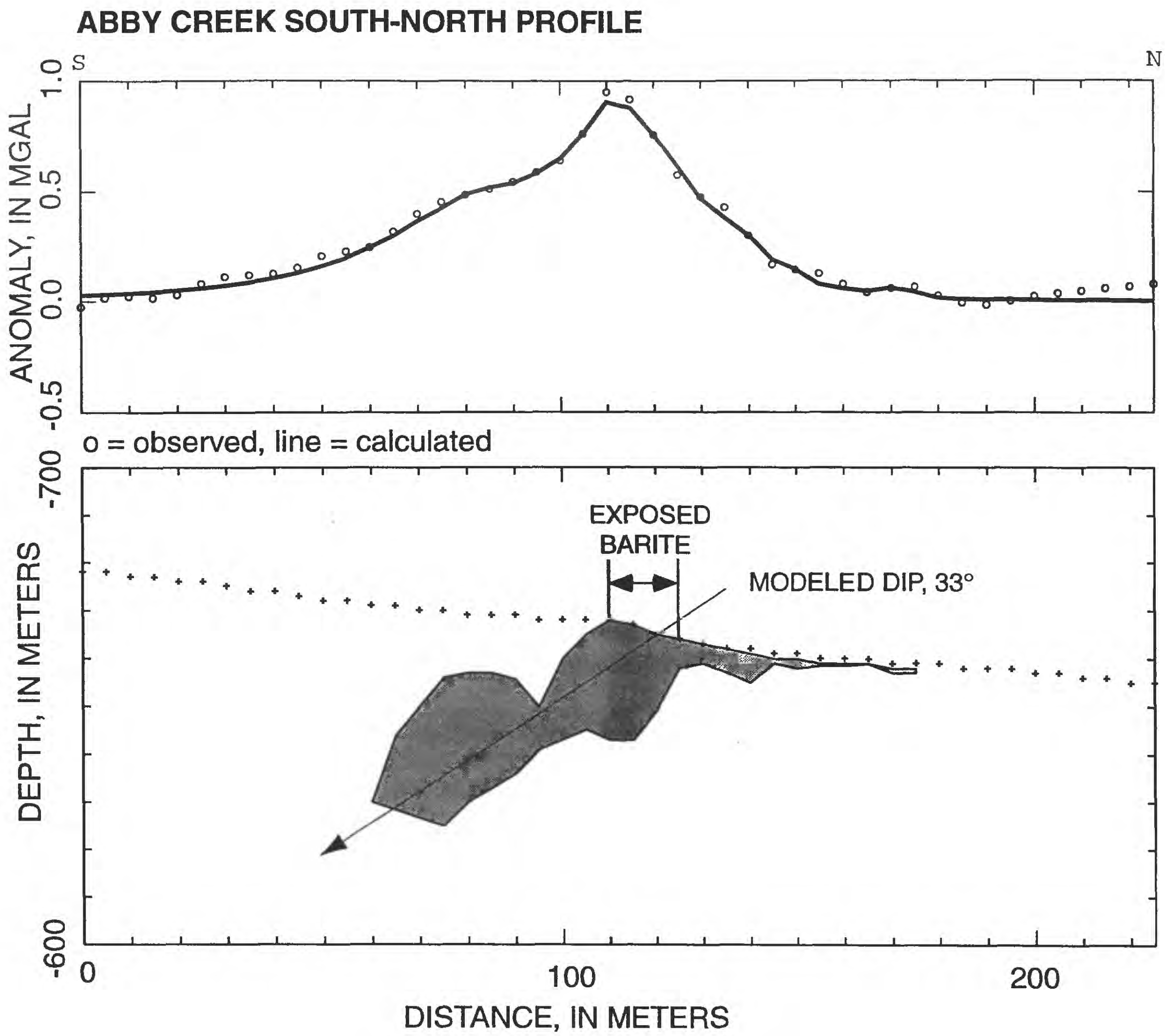

FIGURE 4. Gravity model across the Abby Creek barite deposit. Profile goes from south to north. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

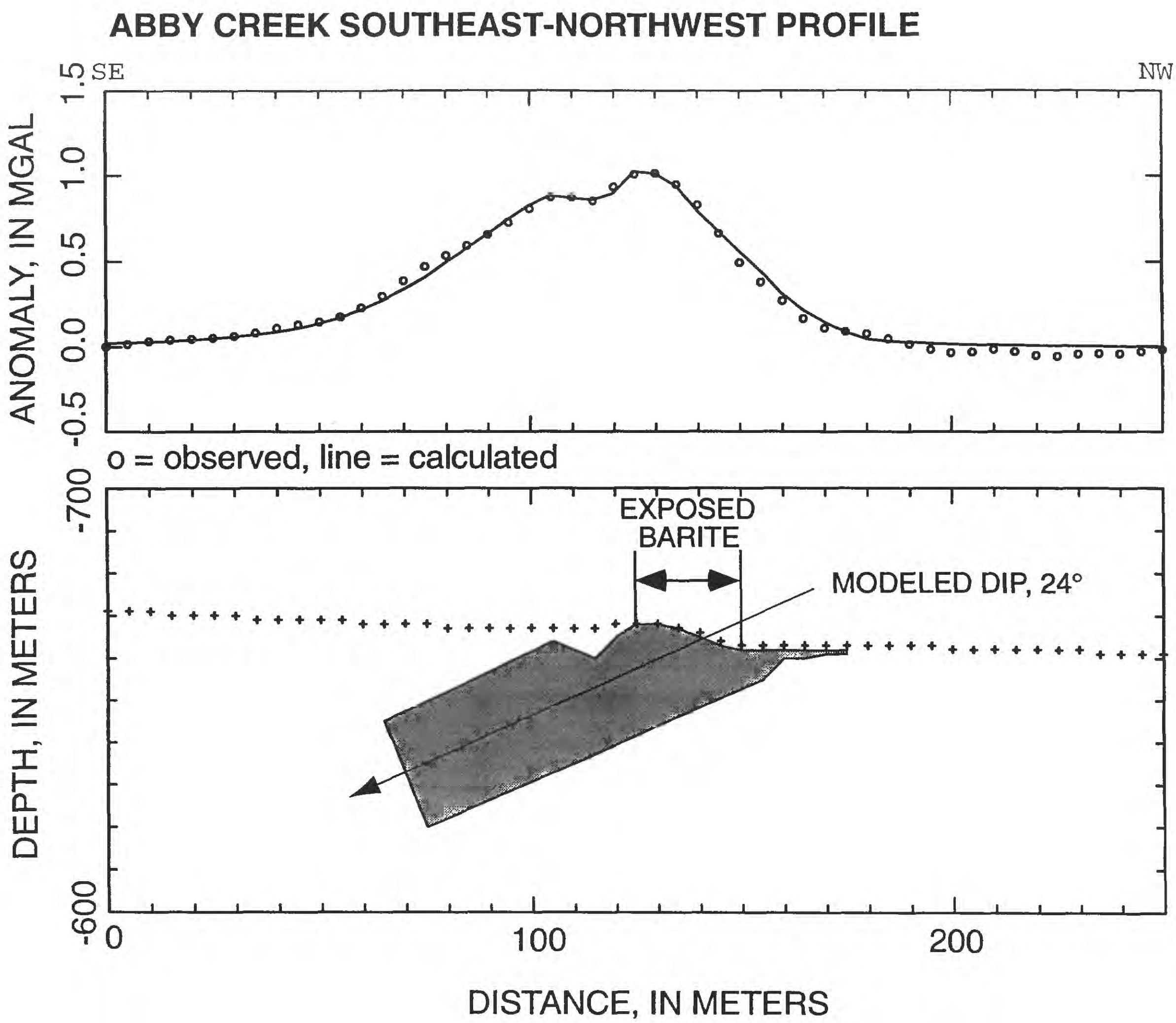

FIGURE 5. Gravity model across the Abby Creek barite deposit. Profile goes from southeast to northwest. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

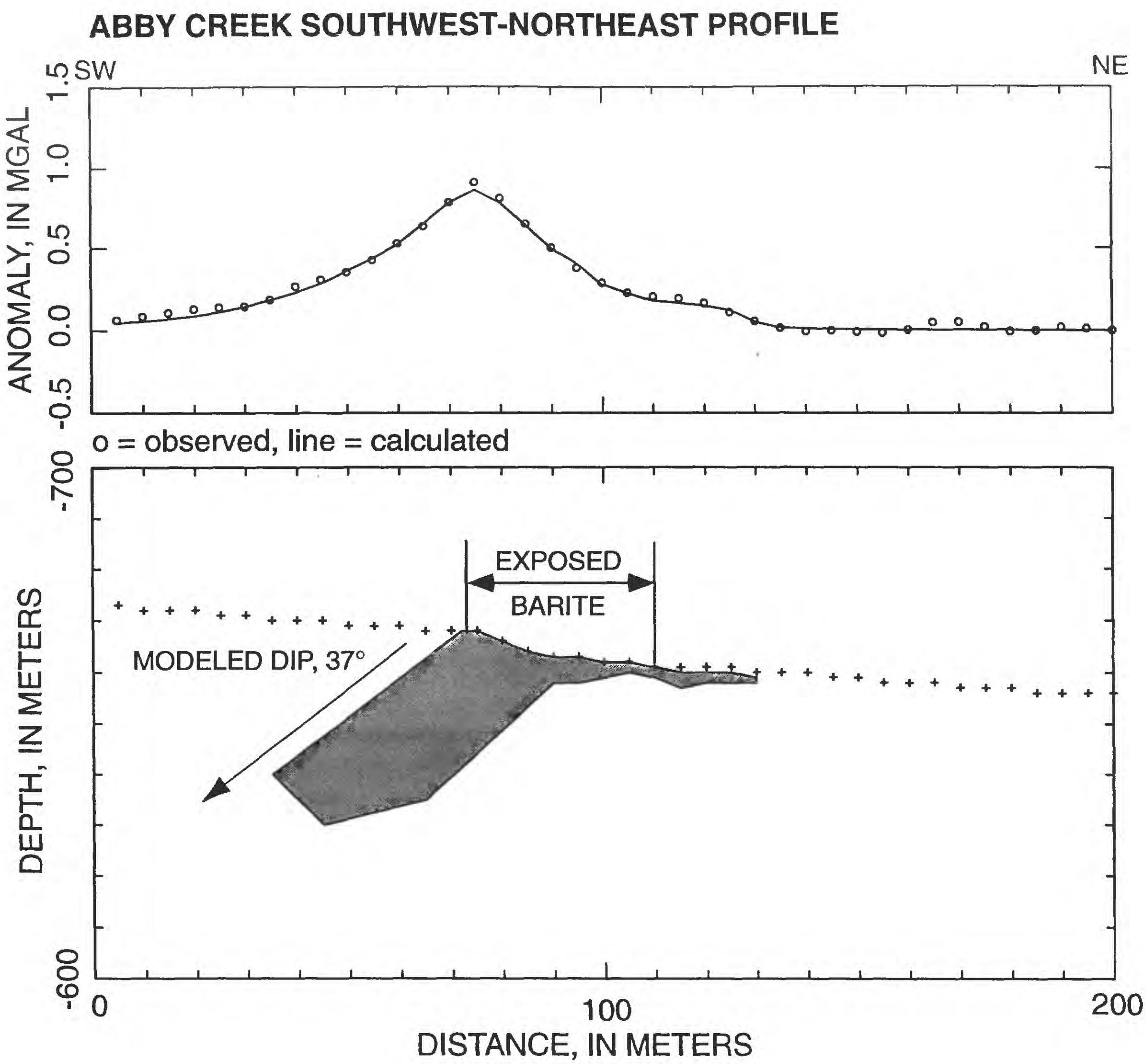

FIGURE 6. Gravity model across the Abby Creek barite deposit. Profile goes from southwest to northeast. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

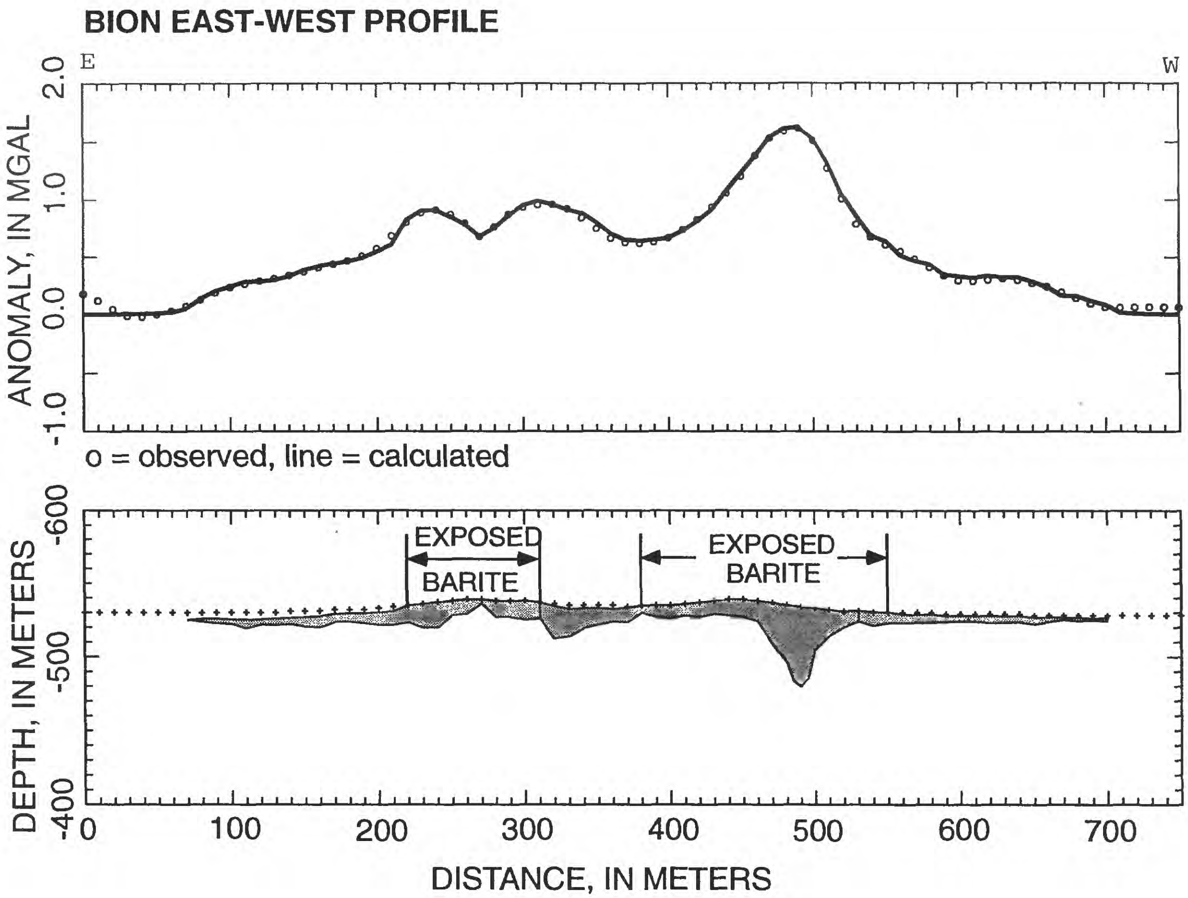

FIGURE 7. Gravity model across the Bion barite deposit. Profile goes from east to west. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

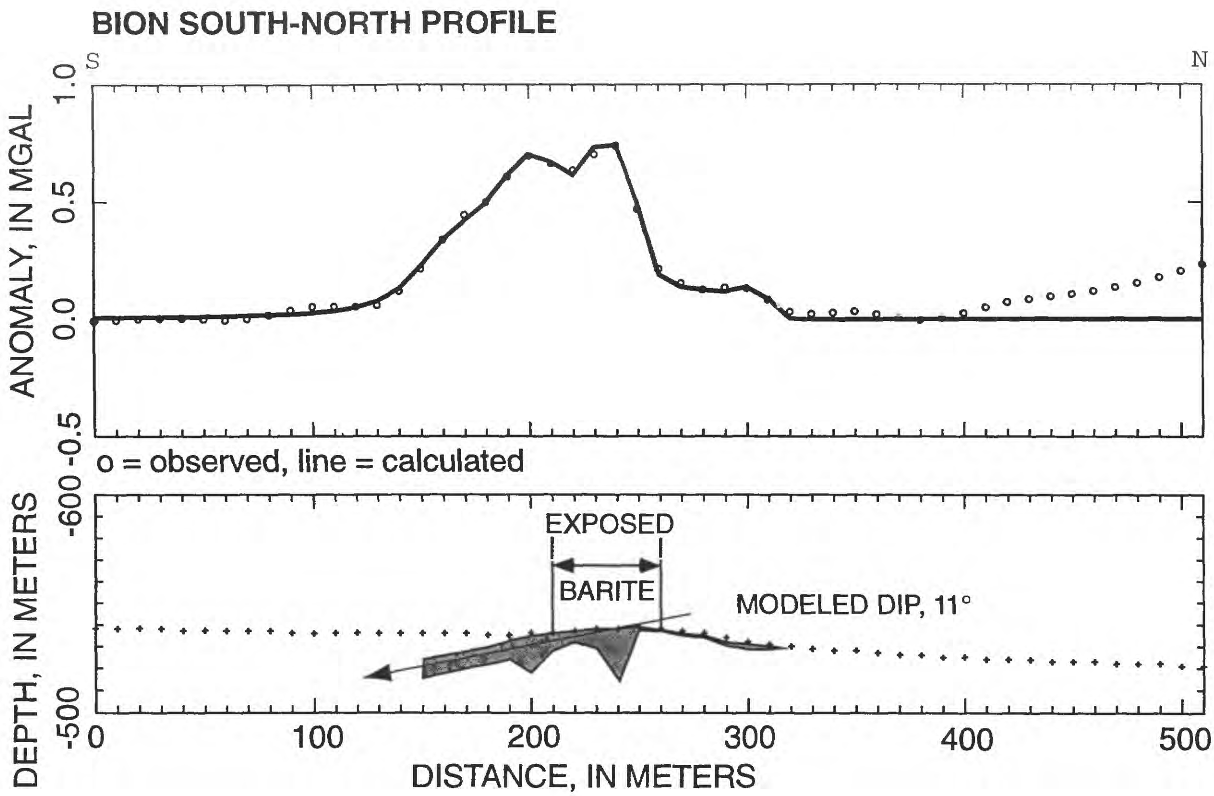

FIGURE 8 Gravity model across the Bion barite deposit. Profile goes from south to north. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

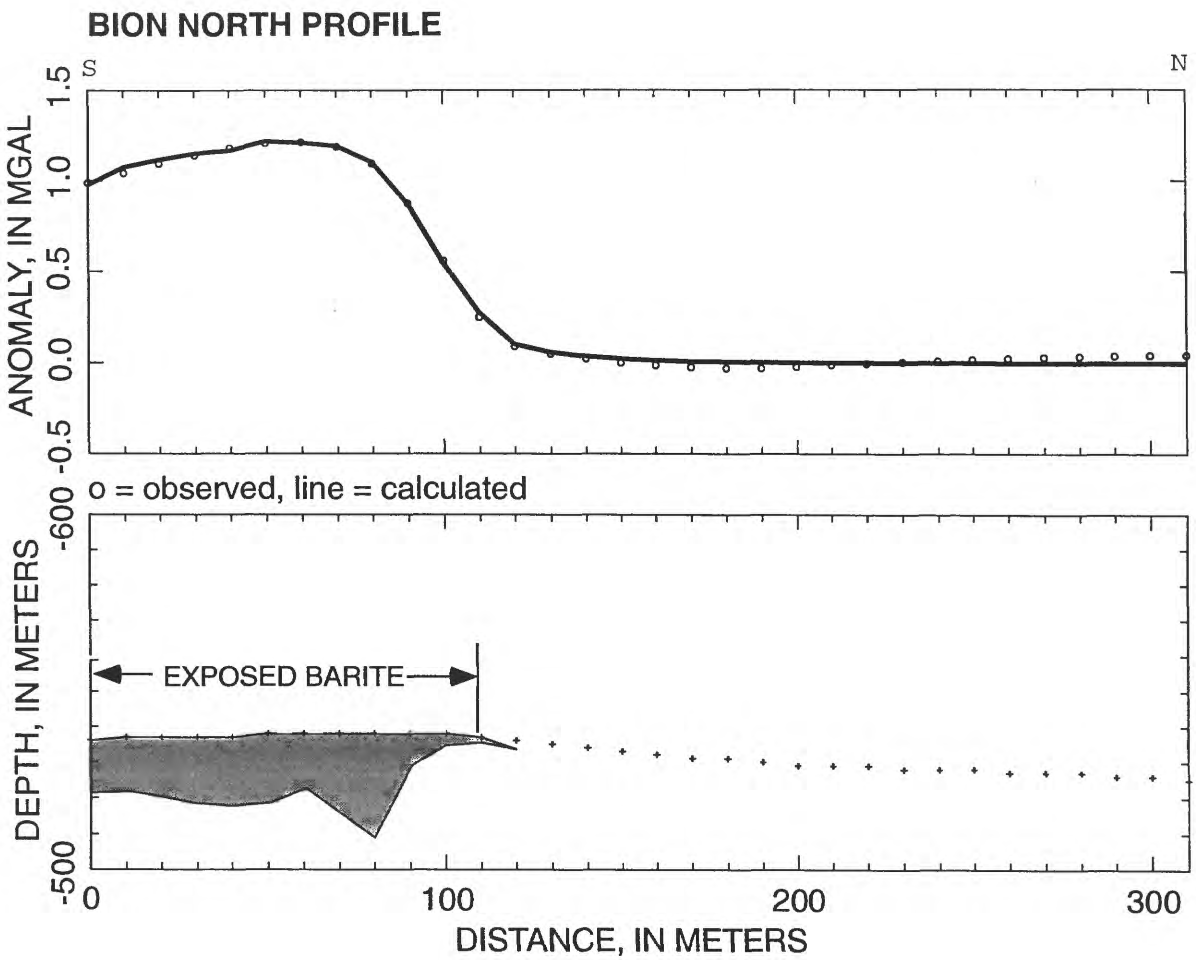

FIGURE 9. Gravity model across the Bion barite deposit. Profile goes from south to north. Small crosses in the depth graph represents the topographic surface. The shaded area represents barite. No vertical exaggeration.

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