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A Review of Aeromagnetic Anomalies in the Sawatch Range, Central Colorado

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Abstract

This report contains digital data and image files of aeromagnetic anomalies in the Sawatch Range of central Colorado. The primary product is a data layer of polygons with linked data records that summarize previous interpretations of aeromagnetic anomalies in this region. None of these data files and images are new; rather, they are presented in updated formats that are intended to be used as input to geographic information systems, standard graphics software, or map-plotting packages.

Introduction

This report contains digital data and image files of aeromagnetic anomalies in the Sawatch Range of central Colorado. The primary product is a data layer of polygons with linked data records that summarize previous interpretations of aeromagnetic anomalies in this region (fig. 1). This data layer is intended to serve as a starting point for future analyses related to U.S. Geological Survey (USGS) mineral resource assessments in the Sawatch Range.

Description of Data

Aeromagnetic data are collected using airborne geophysical sensors that measure subtle variations in the Earth's magnetic field. Magnetic anomaly variations are caused by the irregular distribution of naturally occurring magnetic minerals associated with geologic features.

The aeromagnetic data used in this summary are a subset of the aeromagnetic compilation for the State of Colorado (Oshetski and Kucks, 2000), with the addition of new data in the Leadville–Buena Vista area (Bankey and Goldak Airborne Surveys, 2006). These two reports describe the survey specifications, data quality, and processing methods. Data from individual magnetic surveys are represented at an elevation of 305 meters above ground. The individual grids were then merged into a single total-field grid with a 1,000-meter grid interval. The map projection used for this study is Universal Transverse Mercator (UTM), zone 13 (central meridian of 105^{o} W. longitude, a false easting of 500,000 meters, a false northing of 0 meters), and North American Datum of 1927 (NAD27).

A standard reduction-to-pole filter was applied to the magnetic data grid, resulting in reduced-to-pole (RTP) grid, which corrects for anomaly shifts and distortions that occur at most latitudes owing to the oblique orientation of the measured magnetic field with respect to the Earth's surface (the field is vertical only at the magnetic poles). Declination and inclination of the Earth's field were assumed to be 10.5^{o} and 66^{o}, respectively, for this area.

In order to emphasize magnetic anomalies related to rocks in the shallow parts of the subsurface, a filter was applied to the RTP gridded data. This filter was designed using matched filtering (Phillips, 2001), which resulted in cutoff values of 0.44 kilometer for the high-pass wavelengths, 1.47 kilometers for the medium wavelengths, and 11.3 kilometers for the low-pass wavelengths. The aeromagnetic data grid called "cc_mag_med" that is included in the data directory was created by eliminating the highest and lowest wavelength frequencies. The grid called "cc_mag_low" presents the lowest wavelength frequencies. The high-pass grid shows mostly noise and is not included in this report.

Previous Aeromagnetic Studies in Mineral Assessment Reports

Aeromagnetic data for the Sawatch Range have been studied in previous USGS investigations in order to contribute to mineral resource assessments of public lands (Tweto and Case, 1972; Campbell, 1981, 1985; Campbell and Wallace, 1986; Van Loenen and others, 1989; Boler and Klein, 1990; Toth and others, 1993).

Aeromagnetic anomalies are caused by rocks that contain significant amounts of magnetic minerals (magnetite being the most common); these anomalies reflect variations in the amount and type of magnetic material and the shape and depth of the body of rock. Geometrical factors of anomalies are also dependent on the quality of the airborne magnetic survey such as flight line spacing. In general, igneous rocks and some metamorphic rocks contain enough magnetic minerals to generate magnetic anomalies, whereas sedimentary and metasedimentary rocks commonly are weakly magnetic to nonmagnetic. Aeromagnetic anomaly maps are important tools in mapping surficial and buried igneous rocks. The features and patterns of aeromagnetic anomalies can also be used to delineate details of subsurface geology, including the locations of buried faults and the thickness of surficial sedimentary rocks.

Aeromagnetic anomaly maps have limitations and strengths in their use to locate mineral deposits. Mineral deposits without associated magnetite or pyrrhotite are not expected to create magnetic highs. Some shallow deposits associated with magnetic intrusions may be severed from that source by subsequent faulting. Other deposits may have lost their early-stage magnetite during subsequent hydrothermal alteration. Tertiary stocks (a common source of mineralization) that intrude magnetic Proterozoic crystalline rocks could create small magnetic lows or highs over the stocks or show no anomalies at all, depending on the relative magnetizations of both stock and surrounding rocks.

Average susceptibility values for rocks in the Sawatch Range and vicinity are summarized in table 5 of Toth and others (1993). Proterozoic rocks in this area have a wide range of measured magnetic susceptibilities: the Proterozoic granitoid and gabbroic rocks are generally the most magnetic. Proterozoic metamorphic rocks are generally moderately magnetic, although Proterozoic metasedimentary rocks may be relatively nonmagnetic. Heterogeneous magnetite content in Proterozoic rocks causes many of the magnetic anomaly variations in the Sawatch Range.

Some Tertiary plutons are magnetic and produce conspicuous positive anomalies (for example, Campbell, 1985), but where altered, they may produce relative magnetic lows or plateaus in the regional magnetic field. Other Tertiary intrusions have low susceptibilities and generate no magnetic highs; they may even produce magnetic lows where they intrude more magnetic Proterozoic rocks (for example, Campbell and Wallace, 1986). Many of the known mineral deposits in the Colorado Mineral Belt have no distinctive aeromagnetic expression (Toth and others, 1993).

A data layer of polygons was created by tracing around prominent positive or negative anomalies on the bandpass-filtered RTP aeromagnetic map. In this way, 116 separate polygon anomalies were identified in and surrounding the Sawatch Range (fig. 1). These anomalies were correlated to those described in the detailed interpretive reports listed herein. This information was transferred to an attribute table that is spatially tied to the polygon layer. Next, each polygon was spatially checked with the State geologic map (Green, 1992) to determine whether the anomaly is clearly related to an outcropping or nearby rock type that might be its source. Finally, each polygon was similarly spatially compared to the topographic data to determine whether the anomaly is clearly related to rocks in high or low elevations. The table records created from this process are more fully described in the "readme.txt" file in the data directory.

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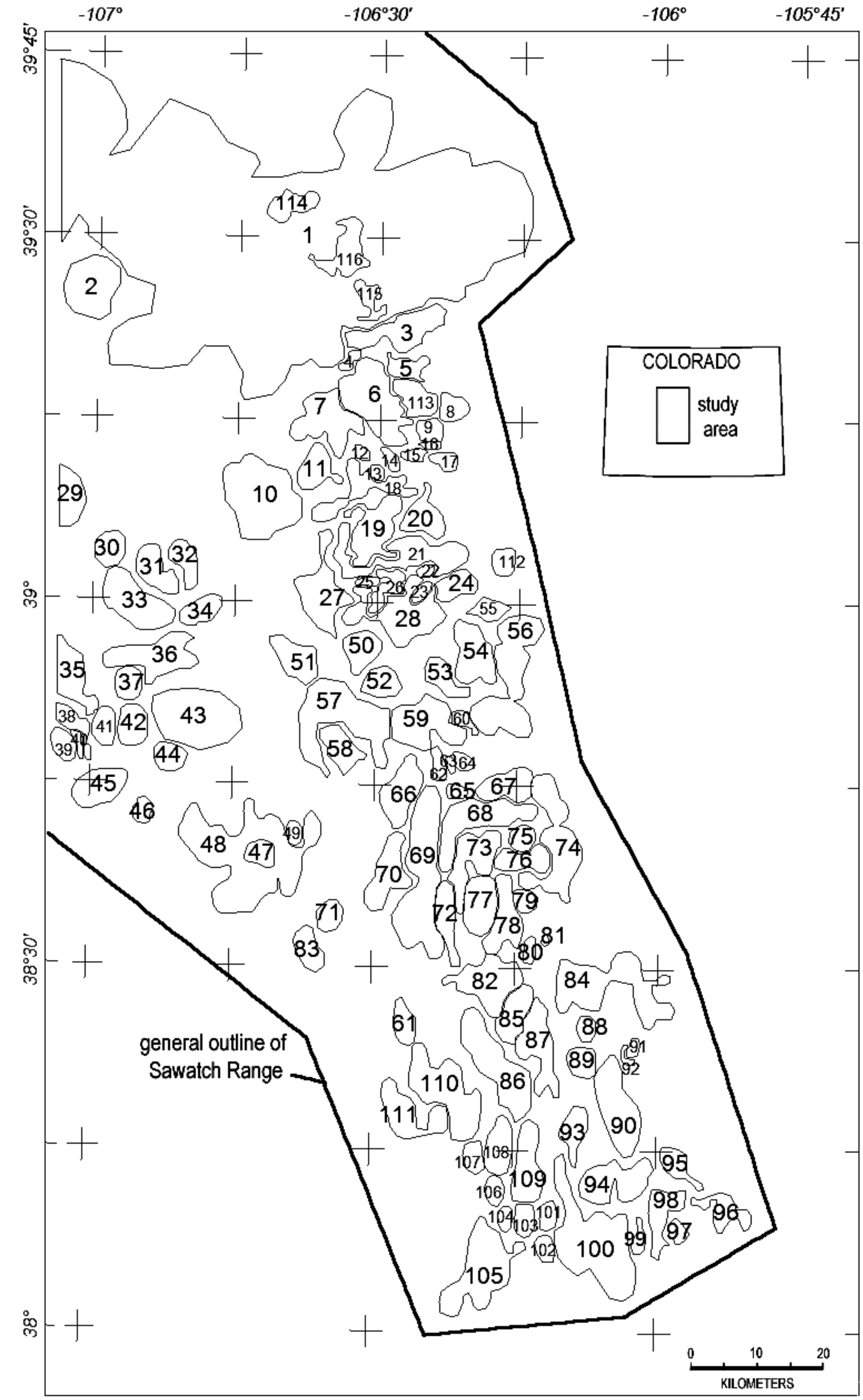

Figure 1. Polygons traced from bandpass-filtered aeromagnetic anomalies of the Sawatch Range, Colorado.