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Chulitna mining district study

by Karen H. Clautice and Rainer J. Newberry

The Chulitna mining district study is one of the latest in a series of ground-based studies by DGGS to accompany the recent airborne geophysical survey program. Bedrock geologic mapping in conjunction with the airborne surveys has been an integral part of the geophysical program since its inception in 1993. The coordinated work is undertaken anticipating that a modern interpretation of a district's geology and mineralization will catalyze exploration and eventual mineral development of the region. New geologic mapping to support recent airborne geophysical surveys has been published for the Circle, Fairbanks, Nome, and Rampart mining districts. Geologic data for the Petersville district will be published shortly; fieldwork began this summer in the Fortymile district and the Iron Creek area of the Talkeetna Mountains.

The Chulitna district is located within Alaska's major railbelt approximately halfway between Fairbanks and Anchorage. The district hosts the Golden Zone deposit and numerous prospects with intriguing values of gold, silver, copper, arsenic, and tin. Much of the mineralization in the district is located within the Chulitna terrane, a northeast-trending belt of rocks that is about 21 miles long and less than 5 miles wide, although important plutonic-related deposits lie outside this belt within the survey area.

Between the summers of 1997 and 1998, about six weeks were spent in the field by an interdisciplinary team that included participants from DGGS, the U.S. Geological Survey (USGS), the University of Alaska Fairbanks (UAF), and a paleontologic consultant. Although mapping was concentrated in the 272-square-mile Healy A-6 Quadrangle (1:63,360 scale), the entire 364-square-mile footprint of the geophysical survey tract was geologically mapped. Work in 1998 was partially funded by the USGS National Cooperative Geologic Mapping Program. To fulfill the USGS contract, four maps and accompanying reports were completed of the Healy A-6 Quadrangle (DGGS Public-Data File 99-24a, b, c, d). These maps include a bedrock geologic map, a surficial geologic map and two computer-generated derivative maps, which combine the bedrock and surficial units into geologic and engineering geologic maps. Accompanying the maps is a report that includes expanded unit descriptions as well as summaries of the geochronology and economic geology of the Healy A-6 Quadrangle. A geologic map of the entire district is in progress as are reports on the paleontology and paleomagnetics of the region. The geologic map of the Chulitna mining district will be published this winter.

The Chulitna work provides a good example of the benefits of the integrated aerial geophysics and ground-truth geology approach to understanding regional geology and mineralization. The distinctive geophysical signatures of some bedrock units combined with distinctive trace element compositions and new paleontologic and stratigraphic observations resulted in an improved picture of bedrock distribution and structural style for this region. United with more accurate radiometric ages for plutonic rocks and mineral prospects, this information allowed us to develop a new stratigraphic–structural model for the district and to clarify relations between the geology and mineral deposits. Some highlights from our work in the Chulitna mining district are summarized below.

Stratigraphy

The abundance of late Triassic fossils in the Chulitna region led earlier workers to assign Triassic or late Paleozoic ages to most of the units. New paleontologic data have yielded some new age assignments and shown that the stratigraphy is commonly overturned. Compositional data further show that the volcanic and volcaniclastic units are commonly indistinguishable from rocks with similar appearance from the central and eastern Alaska Range. These new data indicate that rather than being a unique, postage-stamp-sized mini-terrane, the Chulitna area is simply a variant of the Wrangellia terrane.

Structure

The dominant structures in the map area are young (Tertiary and younger) high-angle faults, as indicated by both geophysical maps and a linear pattern of shallow earthquake epicenters. Early workers mapped high-angle faults in the district because of nearly straight-line surface traces that show no deflection by the more-than-2-kilometer topographic relief. Subsequent workers mapped these as thrust faults to conform to their geologic model of terrane collision. However, abrupt breaks on aeromagnetic maps that correspond with linear zones of high conductivity and to the traces of these faults indicate they are very steeply dipping. In addition, the faults cut across contact metamorphosed and mineralized areas, indicating they are of post-accretionary age.

(continued on page 2)

High-angle faulting

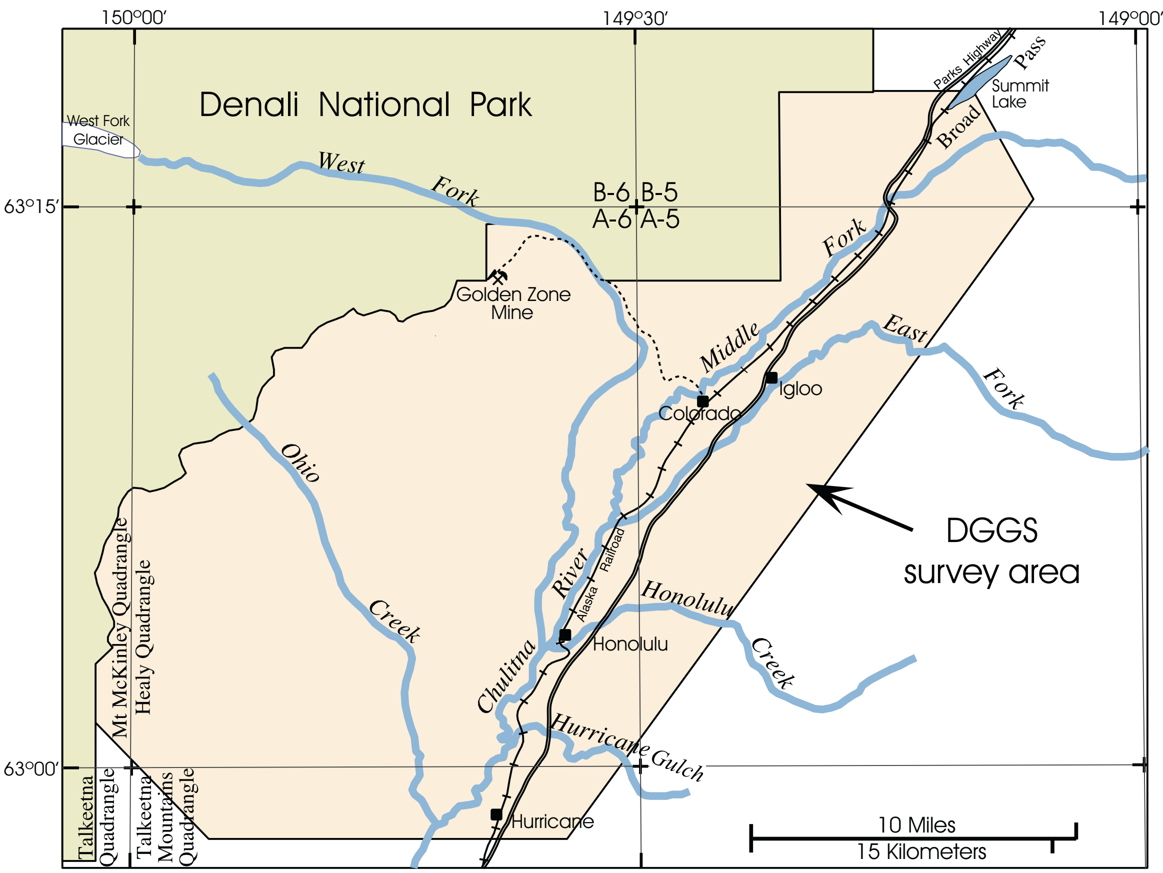
There appear to be three major orientations to high-angle faults in the region: northeast, northwest, and north-northeast. The most continuous faults and those with apparently greatest displacements are the northeast-trending ones. These define the Broad Pass graben and the margins of the Paleozoic "Chulitna" block to the northwest. We have no direct evidence for the amounts of horizontal movement, but to juxtapose the various metamorphic and igneous rocks observed, the vertical displacements must be greater than a kilometer. Near-horizontal slickenlines indicate horizontal movement that we believe to be associated with the Denali fault, and thus may indicate significant horizontal displacement. Veins and dikes are commonly oriented parallel to the northeast-trending faults, and less commonly parallel to the northwest-trending faults. Vertical movement between northeast-trending blocks controls the exposure level of mineralizing plutons and thus surface expressions of mineralization in the region. For example, downdropped blocks show little surface expression of mineralization or igneous rock and in places have preserved Tertiary gravels. Tertiary gravels are eroded from relatively higher blocks, which expose plutons, hornfelsed rock, and mineralized veins.

Low-angle faulting

Indirect evidence suggests that the Paleozoic Chulitna block sits structurally above, but topographically below, the extensive Mesozoic flysch unit (KJs) along a low-angle fault surface. The most striking evidence comes from the Late Cretaceous and Early Tertiary intrusive rocks in the region. Such intrusions cut all pre-Tertiary rocks in the region, but their outcrop sizes vary dramatically between the major fault blocks. Intrusions with indistinguishable ages and compositions occur as large plutons and batholith-sized bodies in unit KJs, but as dikes or small plugs within the Paleozoic block. Given that the intrusions into the KJs commonly occur at higher present topographic elevations than the dikes and plugs in the Chulitna block, these differences can be most readily ascribed to major, post-intrusive uplift of KJs blocks relative to the Paleozoic blocks. Such a relationship, in turn, requires that the Paleozoic rocks be structurally above KJs, hence in thrust contact. Although we have not identified significant low-angle faults in the field, we have identified many southeast-vergent overturned folds and regions of inverted stratigraphy, which commonly accompany low-angle faults.

Economic Geology

The vast bulk of known mineral resources in the Healy A-6 Quadrangle and vicinity are spatially and temporally associated with Cretaceous and Tertiary age intrusions. Although the various prospects and deposits possess similarities, those associated with Late Cretaceous intrusions are fundamentally different from those associated with Early Tertiary intrusions. The former contain significant gold resources and the latter significant silver–tin. Earlier workers drew similar



Location of DGGS airborne geophysical survey and ground-based mapping.

conclusions, but regarded all the intermediate-composition intrusions as older, gold-related, and all the felsic-composition intrusions as younger, tin related. We found exceptions to this, most notably in the large granitic pluton in the southeast portion of the Healy A-6 Quadrangle, which yielded a Late Cretaceous age. In many cases the two deposit types are difficult to distinguish. Arsenopyrite and pyrite are characteristic minerals of both types and anomalous concentrations of tin, bismuth, tellurium, and gold can be found in either type. However, the two types can be distinguished by their gold and silver contents: the silver/gold ratios are higher in most hand samples from the tin–silver-type deposits than in hand samples from the gold-type deposits.

GEOCHRONOLOGY

Twenty-eight new ^{40}Argon/^{39}Argon dates were obtained from mineral prospects and occurrences throughout the district. The advantage of ^{40}Argon/^{39}Argon over the older Potassium–Argon (K–Ar) method is that through step-heating, the argon method dates different thermal events that affect a rock rather than producing an integrated age of all the events. For example, conventional K–Ar dates of the large granite intrusion in the southeast corner of the A-6 quadrangle indicated an Early Tertiary age. Our samples also yielded Early Tertiary integrated ages, but lack a true "plateau." Late Cretaceous high-temperature fraction ages indicate it is of Late Cretaceous age instead. This result has important regional implications beyond the survey area, as it demonstrates that not all of the so-called "McKinley age" granites belong to the younger event generally considered favorable only for tin–silver deposits, but instead may belong to the Late Cretaceous event associated with gold. Hence, the lode gold potential of the region is likely underestimated.◆

Dear Readers:

The coming months promise to be pivotal in defining the direction of public geology in Alaska for the next decade. The State is entering uncharted waters as it wrestles with the difficult questions associated with establishing not only the mechanisms for funding government programs and services, but inevitably, what programs and services it is going to fund at any level. DGGS exists within this environment of change, and it is not reasonable to believe that our programs will not receive close scrutiny. In many respects, DGGS is easy to evaluate. We have a clearly defined mission that is articulated in Alaska Statute 41.08. Our annual budget explicitly states what we will produce, and why. It is our privilege to be the stewards of those geologic programs that are appropriately implemented within the public sector for the benefit of all.

I believe this newsletter's summary of the geologic work recently completed in the Chulitna River area of central Alaska is a good example of the value of having public-sector geologists in the field armed with new methods and focused on generating geologic information to support the state's development. By recognizing, documenting, and publishing the discriminating factors that allow one to distinguish the gold-favorable host rocks in the Chulitna region, the mineral exploration potential of scores of central Alaska plutons is improved. By recognizing that the Chulitna region is not a unique exotic geologic terrane, the lessons learned here can be extended to hundreds of square miles of the Wrangellia terrane, of which Chulitna is a part. These insights are now in the public domain where they will be used to catalyze new ventures and new investment. Providing a better understanding of Alaska's geologic framework is an important part of the state–industry partnership that must be sustained in order for Alaska to prosper.

Sincerely,

Milton A. Wiltse

Milton A. Wiltse
Director and State Geologist

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Faster Web Access!

DGGS has acquired a faster line to the outside world. A new T1 line is now in place, replacing the old 56kb line. This upgrade is supposed to speed up access to the DGGS Web site by a factor of 10. Loading Web pages and downloading files should be much easier now. Funding for this project was provided by the U.S. Geological Survey through the Alaska Data at Risk program. This program is also funding a project to provide on-line access to all DGGS publications, so the upgrade in speed is very timely. Visit our web site at:

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OUT WITH THE OLD . . . AND IN WITH THE NEW!
The Millennium Cleaning Bug strikes at DGGS

We have been cleaning house at DGGS! Some of our report categories have been discontinued and replaced with newer ones that are more carefully defined—and designed to make sense to you, our users. Beginning July 1, 1999, new reports that previously would have been published as Public-Data Files (PDFs) have been published as one of three new report types:

Raw Data File (RDF): Essentially a data dump. Reports in this category do not contain interpretation, are not required to have a technical edit, and have been reviewed only by the project leader to ensure completeness and technical credibility.

Preliminary Interpretive Report (PIR): Includes preliminary field maps and draft geologic reports of investigations. These publications contain interpretation, and have at least one peer review. Layout and editing are the responsibility of the project leader.

Geophysical Report (GPR): Includes geophysical maps, contractors' geophysical reports, and small interpretive reports on geophysical modeling. GPRs generally do not require a technical edit but follow DGGS guidelines for layout. The level of review is determined by the project leader. This category does not include reports with DGGS staff interpretations of the geology based on the geophysical data, which are released either as Preliminary Interpretive Reports (PIR) or Reports of Investigation (RI) with appropriate peer review.

In addition to discontinuing Public-Data File (PDF) reports, we have also deleted the Administrative Report (ADR) category. This leaves DGGS with the following nine active report types:

- Raw Data File (RDF)
- Geophysical Report (GPR)
- Preliminary Interpretive Report (PIR)
- Report of Investigation (RI)
- Professional Report (PR)
- Special Report (SR)
- Miscellaneous Publication (MP)
- Guidebook (GB)
- Information Circular (IC)

We hope that these changes make it simpler for the user and our staff. Please be patient as we become more familiar with the new report categories.

NEW PUBLICATIONS

GPR 1999-1A. Total field magnetics of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-1B. Total field magnetics of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-1C. Total field magnetics of selected areas near Ketchikan, southeastern Alaska—Map C (surveyed area south of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-1D. Total field magnetics of selected areas near Ketchikan, southeastern Alaska—Map D (western and eastern parts, Gravina Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-2A. 56,000 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-2B. 56,000 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-2C. 56,000 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map C (surveyed area south of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $26.

GPR 1999-2D. 56,000 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map D (western and eastern parts, Gravina Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-3A. 7200 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

GPR 1999-3B. 7200 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

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GPR 1999-3C. 7200 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map C (surveyed area south of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Topography included. Full-color plot from electronic file, 600 dpi. Made on request. $13.

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GPR 1999-4A. Flight lines of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Blueline. Topography included. $2.

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GPR 1999-5A. Total field magnetics and electromagnetic anomalies of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Diazo film. Magnetic contours and section lines included. Made on request. $13.

GPR 1999-5B. Total field magnetics and electromagnetic anomalies of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Diazo film. Magnetic contours and section lines included. Made on request. $26.

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GPR 1999-5D. Total field magnetics and electromagnetic anomalies of selected areas near Ketchikan, southeastern Alaska—Map D (western and eastern parts, Gravina Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Diazo film. Magnetic contours and section lines included. Made on request. $15.

GPR 1999-6A. Total field magnetics and electromagnetic anomalies of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Blueline. Magnetic contours and section lines included. $2.

GPR 1999-6B. Total field magnetics and electromagnetic anomalies of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Blueline. Magnetic contours and section lines included. $3.

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GPR 1999-7A. 56,000 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Blueline. Resistivity contours and section lines included. $2.

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GPR 1999-8A. 7200 Hz coplanar resistivity of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. Blueline. Resistivity contours and section lines included. $2.

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GPR 1999-10A. Color shadow magnetic map of selected areas near Ketchikan, southeastern Alaska—Map A (Salt Chuck and Kasaan Peninsula, Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. $13.

GPR 1999-10B. Color shadow magnetic map of selected areas near Ketchikan, southeastern Alaska—Map B (surveyed area immediately north of 55° 15', Prince of Wales Island), by L.E. Burns, Geoterrex-Dighem, and WGM Staff, 1999, 1 sheet, scale 1:63,360. $13.

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