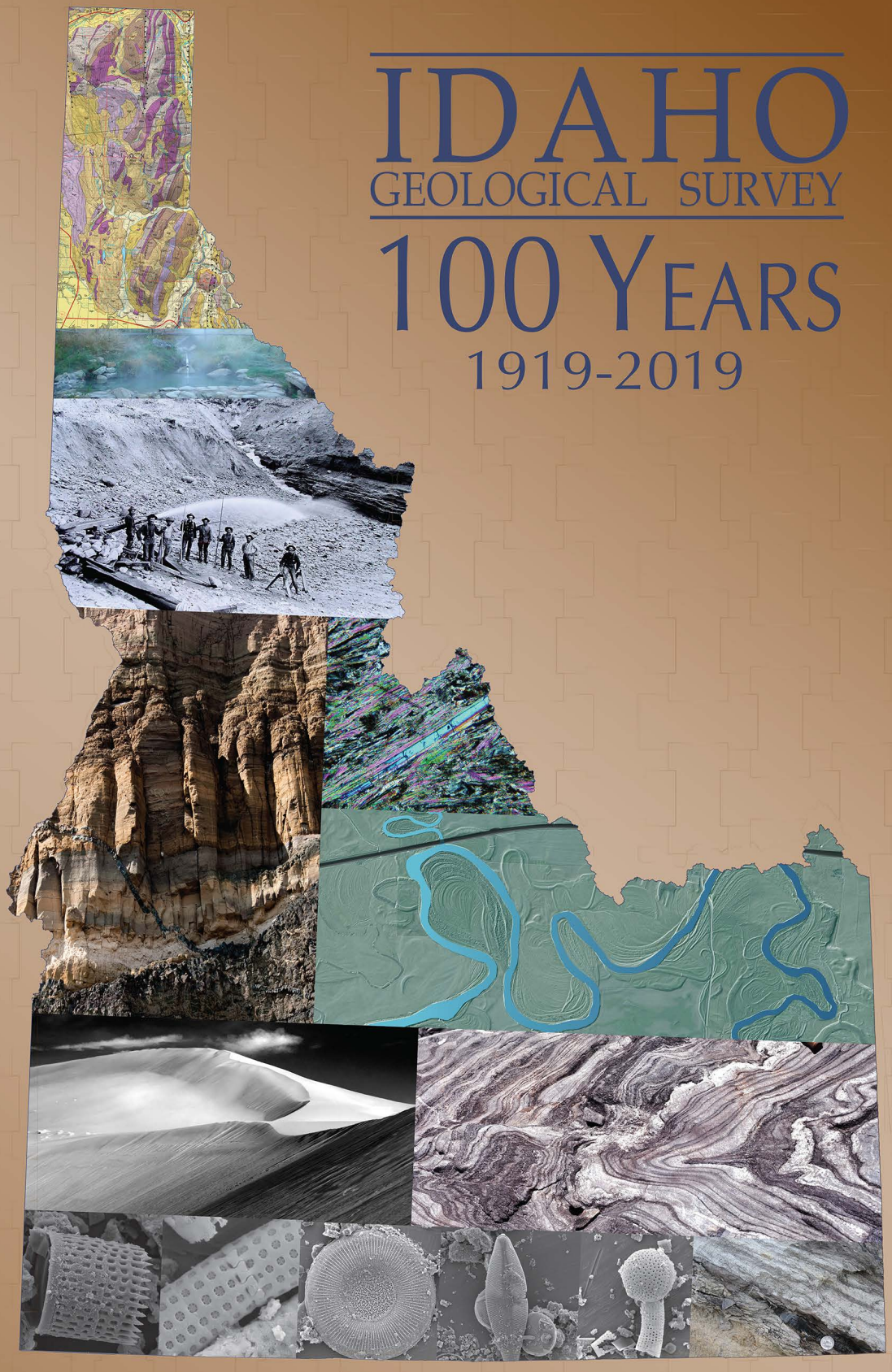
IDAHO GEOLOGICAL SURVEY

100 YEARS

1919-2019



ANNUAL REPORT
FISCAL YEAR 2019

Annual Report of the Idaho Geological Survey

Fiscal Year 2019

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INTRODUCTION

Idaho Geological Survey (IGS) is the lead state agency for the collection, interpretation, and dissemination of geologic and mineral resource data for Idaho. The agency has served the state since 1919 and prior to 1984 was named the Idaho Bureau of Mines and Geology. Idaho Code Title 47, Chapter 2 provides for the creation, purpose, duties, reporting, and offices of the Survey, and establishes the IGS Advisory Board. The IGS is a non-regulatory state agency that is administered as a Special Program of the University of Idaho. The Survey has an office in northern Idaho on University of Idaho's Moscow campus and an office in southern Idaho at the Idaho Water Center in Boise. The agency is staffed by approximately 12 state-funded FTEs and 15 externally-funded temporary and part-time employees.

The Survey's mission is to provide the state with timely and relevant geologic information. IGS is committed to the advancement of geosciences and emphasizes the practical application of geology to benefit the citizens of the state. The Survey accomplishes its mission through applied geologic research and strong collaborations with federal and state agencies, academia, private sector partnerships, community service, and educational outreach activities.

Members of the IGS staff acquire geologic information through field and laboratory investigations and through sponsored and cooperative research programs with partners at the local and federal level. The Survey's geologic mapping program is fundamental to solving and identifying a wide array of geologic problems and issues throughout the state. Both bedrock and surficial geologic maps, and the derived subsurface interpretation, constitute a fundamental and objective scientific foundation on which land, water, mineral, and energy resource decisions are based. The Survey is a leader in the National Cooperative Geological Mapping Program, and over 210 geologic maps have been published from this program and are available for download from the agency website.

The IGS Digital Mapping Laboratory is central to compiling, producing, and delivering digital geologic map products, technical reports, and publications from the geologic staff. Geographic information system (GIS) technology has changed geologic maps by providing tools that enable geologic resources and structural features to be electronically stored, displayed, queried, and analyzed in conjunction with a variety of other data types.

Other major research programs at the IGS include geologic hazards, hydrogeology and groundwater, geothermal energy, oil and gas, metallic and industrial minerals, mining record compilations, and earth science education and outreach. As Idaho grows, demand is sharply increasing for geologic information related to energy, mineral, and water-resource development, and geologic hazards, such as landslides and active faults with accompanying earthquakes.

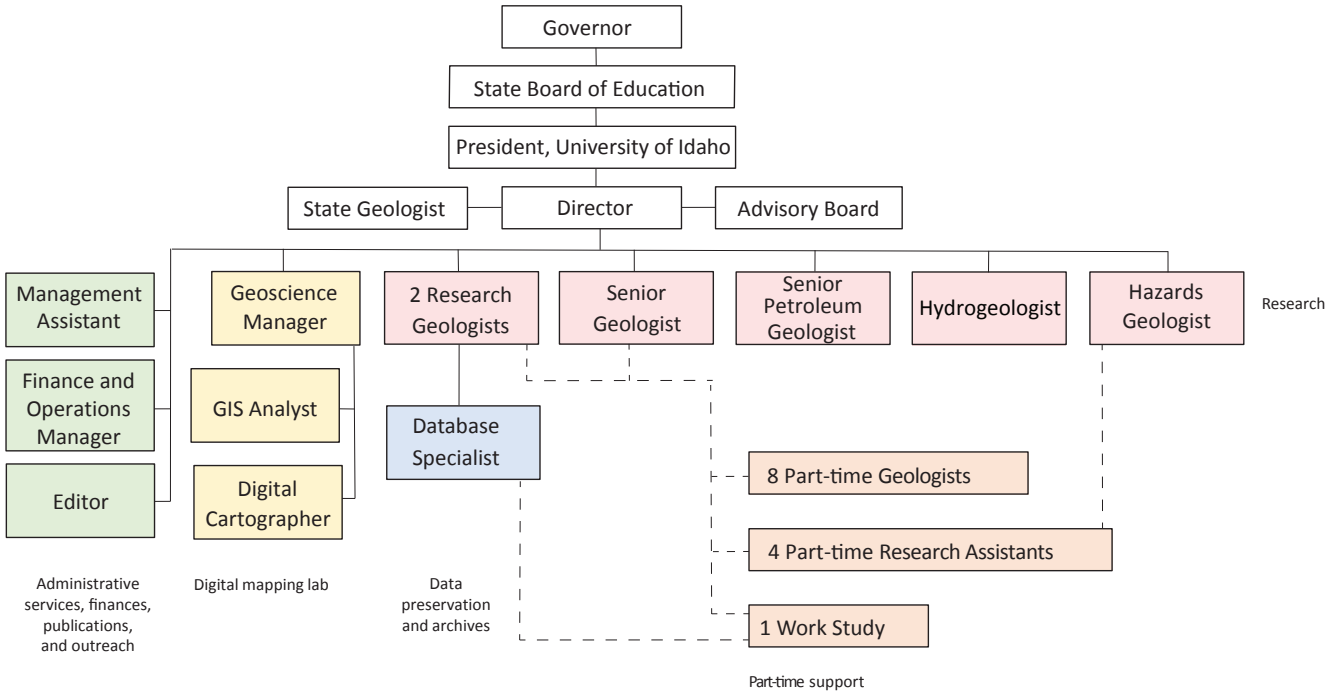
Over time, the staff has developed wide-ranging, interdisciplinary networks in support of its mission. Please refer to the *Partnerships* section for the many organizations currently involved in Survey projects. Details of the staff's professional engagement in the agency's mission are listed in the *Publications and Activities* section of this report.

Organization and Personnel

The IGS provided geological services during fiscal year (FY) 2019 from offices in Moscow and Boise. Glen Downing, Director of Research Operations and Strategic Initiatives, filled the role of Acting Director until November 2018 when Peter Isaacson was hired as Interim Director. Ed Ratchford served as State Geologist for FY 2019. The Digital Mapping and GIS Lab Manager position was filled by Claudio Berti who is stationed in the Moscow office. A national search for a Senior Geologist began in May 2019, and as of the end of the fiscal year the search committee began screening and selecting applicants for interviews.

The organization chart below represents personnel and reporting effective during FY 2019.

Organization Chart



Directory

Moscow Office

University of Idaho
Morrill Hall, Third Floor
875 Perimeter Drive MS 3014
Moscow, ID 83844-3014
208-885-7991

Boise Office

Idaho Water Center
Suite 201
322 E. Front Street
Boise, ID 83702
208-332-4420

Administrative and Support Staff

Glen R. Downing ..... Acting Director, Moscow (July 2018-November 2018)
Peter Isaacson ..... Interim Director, Boise (November 2018-June 2019)
Michael E. Ratchford ..... State Geologist, Moscow
John R. Brabb ..... Finance and Operations Manager, Moscow
Kristen M. Pekas ..... Management Assistant, Moscow

Research, Full-Time

Mark Barton ..... Senior Petroleum Geologist, Boise
Claudio Berti ..... Digital Mapping and GIS Lab Manager, Moscow
Alexis Clark ..... Hydrogeologist, Boise
Dennis M. Feeney ..... Senior Geologist, Moscow
Virginia S. Gillerman ..... Research Geologist, Boise
Reed S. Lewis ..... Research Geologist, Moscow
Zach Lifton ..... Hazards Geologist, Boise
Jonathan E. Sandquist ..... Digital Cartographer, Moscow
Christopher A. Tate ..... Mines and Prospects Database Manager, Moscow
Linda Tedrow ..... GIS Analyst, Moscow

Research and Support, Part-Time

Russell F. Burmester ..... Geologist
Andrew Canada ..... Geologist
Kevin Cerna ..... Research Assistant
James C. Coogan ..... Geologist
Skye W. Cooley ..... Geologist
Scott Ducar ..... Research Assistant
Kurt L. Othberg ..... Geologist
Beverly Rice ..... Research Assistant
D. Kate Schalck ..... Geologic Editor
Keegan L. Schmidt ..... Geologist
William Schuster ..... Research Assistant
David E. Stewart ..... Geologist
Eric D. Stewart ..... Geologist
Hailey Terchowitz ..... Work Study

Idaho Geological Survey
Advisory Board

Leslie Baker
Chair, Department of Geological Sciences,
University of Idaho

Susan Cleverly
Mitigation Section Chief, Idaho Office of
Emergency Management

Chris Dail
Exploration Manager,
Midas Gold Idaho, Inc.

David Hawk
Representative, Office of the Governor

Mike McCurry
Chair, Department of Geological Sciences,
Idaho State University

James "Jim" McNamara
Chair, Department of Geological Sciences,
Boise State University

Dan Moore
Professor, Department of Geology,
Brigham Young University - Idaho

Keith Nottingham
Geologist, American Geotechnics

Rich Reed
President,
Idaho Association of Professional Geologists

Ex Officio: Glen R. Downing
Acting Director,
Idaho Geological Survey
(July 2018-November 2018)

Ex Officio: Peter Isaacson
Interim Director,
Idaho Geological Survey
(Novermber 2018-June 2019)

Idaho Geological Mapping Advisory Committee

Janet Hohle – Chair
Project Manager - Clearwater Focus Program
Idaho Governor's Office of Species Conservation

Shawn Enright
District Geologist
Idaho Transportation Department

David Hawk
Representative, Office of the Governor
IGS Advisory Board
E2A Energy Analysis and Answers

Dale Kerner
Permitting Manager
Midas Gold Idaho, Inc.

Mark Kimsey
Research Assistant Professor
Intermountain Forestry Cooperative
Department of Forest, Rangeland and Fire Sciences
University of Idaho

Robin Kiska
Risk MAP Program Manager
Idaho Office of Emergency Management

Sean Long
Associate Professor, Earth Sciences
Washington State University

Jonathan Moore
Project Geologist
Hecla Mining Company

Shawn Nield
State Soil Scientist
U.S. Department of Agriculture
Natural Resources Conservation Services

Dennis Owsley
Technical Hydrogeologist
Idaho Department of Water Resources

David Pearson
Assistant Professor, Department of Geosciences
Idaho State University

Karen Porter
Geologist
Program Lead Leasable and Salable Minerals
Idaho State Office, Bureau of Land Management

John Rice
President
Rocky Mountain Environmental Associates, Inc.

Diane Wheeler
Forest Geologist
Caribou-Targhee National Forests

Fiscal Overview

In FY 2019, the Legislature funded the IGS for salary, related benefits, and operations and additional one-time capital outlay funding. The Survey's state appropriated budget for FY 2019 was $1,085,100, a $4,700 increase from $1,080,400 in FY 2018. This increase is due to adjustments in personnel and one-time funding allocations.

Grant and contract expenditures decreased from $347,857 in FY 2018 to $283,673 in FY 2019 due to the majority of summer field work in 2019 occurring after the end of the fiscal year. Expenditures came from 14 projects in FY 2019 compared to 12 projects in FY 2018. In FY 2019, IGS acquired extramural funding from new and non-traditional funding sources. In addition to ongoing U.S. Geological Survey (USGS) and Idaho Department of Lands (IDL) awards, IGS secured funding for geologic mapping near the Stibnite mining district (Wilmat Petroleum), geologic mapping relevant to the De Lamar mine (Integra Resources), hydrogeological investigation of the Big Lost River Basin (Idaho Department of Water Resources), and integrating Idaho geology with Macrostrat (Arizona Geological Survey/National Science Foundation). Expenditures from these awards will have a large impact on grant and contract expenditures in FY 2020.

Budget for Fiscal Year 2019

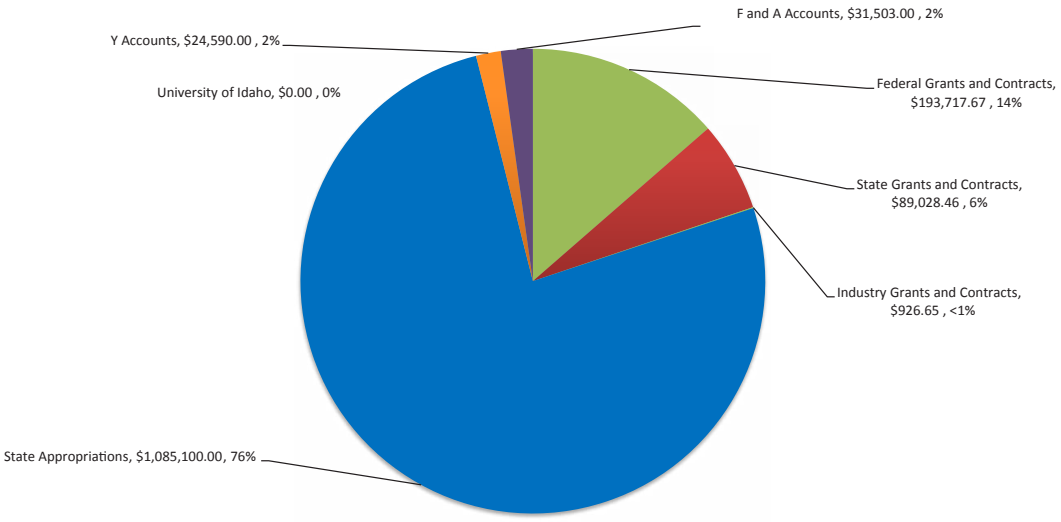
Category	Beginning Balance	Income or Appropriation	Actual	Expense	Ending Balance
Personnel	-	$ 1,052,100.00	$ 974,399.00	$ 974,399.00	$ -
Operating Expense	-	$ 33,000.00	$ 105,337.00	$ 105,337.00	$ -
Capital Outlay	-	$ -	$ 5,364.00	$ 5,364.00	$ -
Total Appropriations	-	$ 1,085,100.00	$ 1,085,100.00	$ 1,085,100.00	$ -
UI Personnel Funds	-	-	-	-	-
Y Accounts	$ 20,020.00	$ 47,712.00	-	$ 24,590.00	$ 43,142.00
F and A Accounts	$ 100,280.16	$ 16,000.00*	-	$ 31,502.77	$ 84,777.39
Grants and Contracts	$ 358,438.85	$ 208,072.23	$ 283,673.00	$ 283,673.00	$ 282,838.08
TOTAL	$ 478,739.01	$ 1,356,884.23	$ 1,368,773.00	$ 1,424,866.77	$ 410,757.47

*Income is estimated.

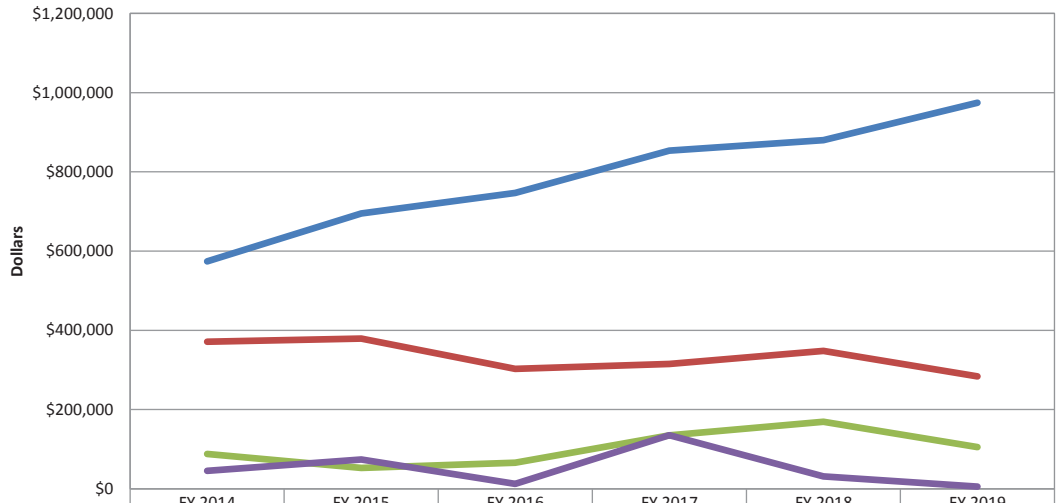
In May 2018, IGS requested additional FTE (full-time equivalent) to increase the Management Assistant and Senior Geologist positions to 1.0 FTE each ($57,300 salary and benefits, .44 FTE) and additional salary compensation ($95,600) to meet University market rate recommendations for FY 2020. The additional FTE and salary funding ($152,900 total additional base funding), along with continuation of existing funding for salary, related benefits, and operations totaled a $1,238,000 request. An additional capital outlay of $8,600 was also part of the FY 2020 request. The Legislature funded at a level consistent with FY 2019 salary, related benefits, and operations base budget with a moderate 3% cost of living increase which was used to offset rising benefit costs. The legislature approved the capital outlay request for $8,600 of one-time funding for equipment replacement. The additional FTE and salary compensation requested was not funded.

For FY 2021, IGS requested additional FTE to increase the Management Assistant and Senior Geologist positions to 1.0 FTE as well as the additional salary compensation to meet University market rate recommendations and increased benefits rates ($217,200 total additional base funding), additional ongoing operations funding ($20,000), one-time operations for project seed funding ($60,000), one-time repair/replacement funding ($235,200), and one-time capital outlay funding ($15,000). Total for this request is $574,400 which is a considerable increase over previous years, but it represents what IGS needs to keep geological research moving forward in support of its mission. Of the total request, the salary and benefits compensation ($217,200) has been submitted and denied multiple times in the past and is now a financial priority for the agency. The FY 2021 request is pending. The Survey does not receive any funding from University sources.

Sources of Funding
FY 2019



Trends in Expenditures
FY 2014-2019



	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Personnel	$573,945	$694,821	$746,726	$853,400	$880,169	$974,399
Grants and Contracts	$371,023	$379,094	$302,424	$314,970	$347,857	$283,673
Operating Expense	$87,772	$52,550	$65,899	$134,696	$169,101	$105,337
Capital Outlay	$45,183	$73,729	$12,566	$135,204	$31,103	$5,364

PARTNERSHIPS

The Survey's statewide mission encourages interdisciplinary partnerships and collaboration with many other agencies, organizations, and universities. This broad cooperation ranges from grant-funded research projects to the collegial sharing of expertise and information. On the national level, the IGS is also directly involved in the initiatives of the Association of American State Geologists (AASG). These alliances offer many opportunities to engage in projects that enhance the agency's mission through applied research and outreach.

Association of American State Geologists

The IGS attended the Annual Meeting of AASG last June held at Fairmont Hot Springs, Montana. The AASG is a strong advocate for the funding and reauthorization of the USGS National Cooperative Geologic Mapping Program as well as research programs for data preservation, minerals, energy resources, and geologic hazards. AASG is an important partner with state geological surveys working collaboratively with many federal agencies including USGS, U.S. Forest Service (USFS), Federal EmergencyManagement Agency (FEMA), National Aeronautics and Space Administration (NASA), Environmental Protection Agency (EPA), and National Science Foundation (NSF). AASG as an association, as well as its members, are a valuable resource for everyday operations at the IGS where advice can be sought from geologic surveys across the nation for issues ranging from alternative funding sources to engaging in geoscience policy at the state and national level.

Funding Partners

Arizona Geological Survey/National Science Foundation (Integrating Idaho geology with Macrostrat)

Federal Emergency Management Agency (LiDAR training and outreach)

Idaho Department of Lands (Abandoned Mine Lands Project)

Idaho Department of Water Resources (Big Lost River Valley)

Idaho Transportation Department (Landslide Inventory Database)

Integra Resources (De Lamar and Swisher Mountain mapping)

U.S. Geological Survey (Statemap Program; Data Preservation)

Wilmat Petroleum Company (Yellow Pine mapping)

Collaborators

Alta Science & Engineering, Inc.
Allen Hoffman Geophysical
American Exploration and Mining Association
American Geosciences Institute
American Water Resources Association, Idaho State Section
Arizona Geological Survey
Association of American State Geologists
Belt Association
Boise State University
Brigham Young University-Idaho
Bryant University
California Geological Survey
Cedar Creek Resources
Center for Advanced Energy Studies
Central Washington University
Centro Nacional de Investigación sobre la Evolución Humana
China Geological Survey
China University of Geosciences
College of Idaho
College of Western Idaho
Earthquake Engineering Research Institute
Federal Emergency Management Agency
Franklin and Marshall College
Geological Society of America
Geomark Laboratories
Governor's Office, State of Idaho
Hecla Mining Company
Hells Canyon Gem Club
High Mesa Holdings
Ice Age Floods Institute
Idaho Department of Environmental Quality
Idaho Department of Lands
Idaho Department of Water Resources
Idaho Gem Club
Idaho Governor's Office of Energy and Mineral Resources
Idaho Ground Water Monitoring Technical Committee
Idaho Lidar Consortium
Idaho Mining Association
Idaho Museum of Mining and Geology
Idaho Office of Emergency Management
Idaho Oil and Gas Conservation Commission
Idaho Public Television
Idaho Science Teachers Association
Idaho State Historical Society
Idaho State University
Idaho Transportation Department
Idaho Water Resources Research Institute
Idaho Youth ChalleNGe Academy
IHS Energy
Intermountain Forestry Cooperative
Isotech Laboratories
Latah County Library
Lehigh University
Lewis-Clark State College
Lone Tree Petroelum
Midas Gold Idaho, Inc.
Missouri State University
Montana Bureau of Mines and Geology
Nevada Bureau of Mines and Geology
Northwest Knowledge Network
Oklahoma Geological Survey
Oregon State University
Orma J. Smith Museum of Natural History
Owyhee Gem and Mineral Society
Palouse Prairie Charter School
Society of Mining Engineers, Boise Section
Schlumberger Petroleum Services
Snake River Oil and Gas
Spokane Community College
Tobacco Root Geological Society
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Forest Service
U.S.D.A. Agriculture Research Service
U.S.D.A. Natural Resource Conservation Service
U.S. Geological Survey—Cascade Volcano Observatory
U.S. Geological Survey—Data Preservation
U.S. Geological Survey—Energy and Unconventional Fuels
U.S. Geological Survey—Geologic Hazards Science Center
U.S. Geological Survey—Minerals Program
U.S. Geological Survey—National Cooperative Geologic Mapping Program
U.S. Geological Survey—National Geospatial Program
U.S. Geological Survey—Water Resources Division
University of Alaska, Fairbanks
University of Idaho
University of Montana
University of Rochester
University of Utah
Utah Geological Survey
Utah State University
Washington Division of Geology and Earth Resources
Washington State University
Weatherford Laboratories
Western Colorado University
Western States Seismic Policy Council
Wyoming Geological Survey
Yellowstone Volcano Observatory

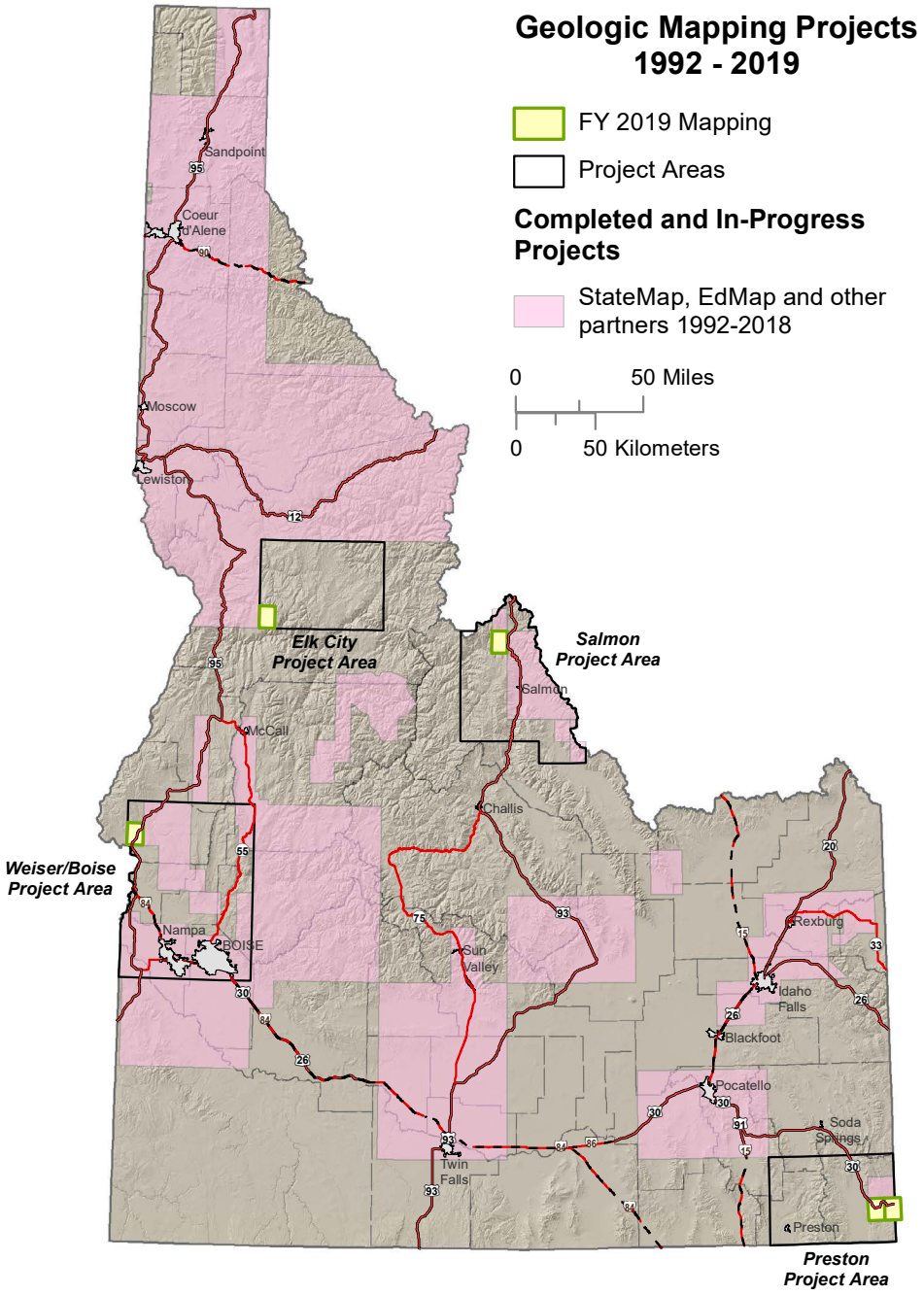
Research

Applied geologic research is the primary function of the IGS. Projects are related to geologic mapping, hydrogeology, geologic hazards, mineral resources, geothermal energy, and oil and gas.

Geological Mapping and Related Studies

IGS conducts ongoing geologic mapping of 7.5′ and 30′x 60′ quadrangles. The Idaho Geologic Mapping Advisory Committee (IGMAC) assists the Survey by assessing Idaho's mapping necessities and addressing long-term plans for geologic mapping. In the last two decades, the Survey has been mapping in areas selectively to address development impacts in urban settings, for recognition and assessment of new mineral, aggregate, and oil and gas resources, and identification and monitoring of geologic hazards such as earthquake seismicity and landslides. Idaho's geologic map products are the primary tool for sharing and distributing geologic information to Idaho's constituents. The geologic maps and associated data are used across disciplines and by diverse stakeholders for a variety of tasks, including delineating rock units that form boundaries of aquifers and defining groundwater resources; designating landslide hazards; defining mineralization potential; delineating and quantifying geologic materials for engineering needs; aiding in highway design and construction; and defining geologic resources on public lands, including federal lands, parks, recreation areas, and state endowment lands.

Funding of Idaho's geologic mapping program is shared by the Statemap component of the USGS National Cooperative Geologic Mapping Program and the Survey. Since 1993, Idaho has received over $4.3 million in federal funds and matched an equal amount of "in kind" salaried employee's participation to complete geologic mapping in Idaho. In FY 2019, new mapping was conducted in the Weiser-Boise, Preston, Elk City, and Salmon project areas. During the year, Survey geologists mapped five 7.5′ quadrangles (Weiser North, Border, Pegram, Hanover Mountain, and Ulysses Mountain) under the Statemap Program. Work in the Ulysses Mountain quadrangle included cooperative efforts with the Montana Bureau of Mines and Geology. One 7.5′ quadrangle map from the Rexburg project area was published and made available to the public on the IGS website (*Geologic Map of the Hawley Gulch Quadrangle, Bonneville and Madison Counties, Idaho,* Digital Web Map 186).

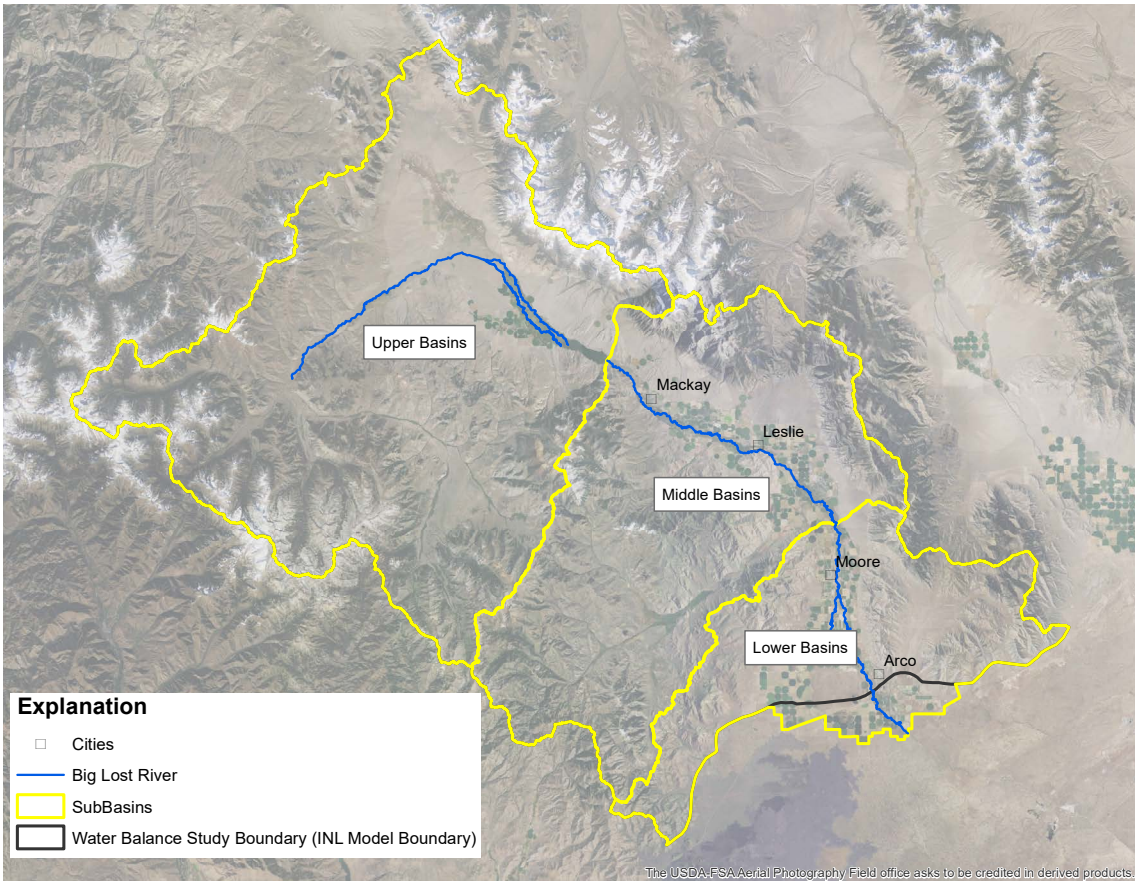


Progress of the geologic mapping effort in Idaho, 1992-2019.

Hydrogeology

Primary hydrogeologic activities performed by IGS during FY 2019 included contracting and initiating work for preparation of groundwater budgets for the Big Lost River Valley, publication of several manuscripts and associated well databases for the Moscow-Pullman Basin, and continued public service, outreach and education efforts for the state.

Under a cooperative agreement with Idaho Department of Water Resources (IDWR), IGS is preparing groundwater budgets at a watershed scale for the Big Lost River Valley groundwater study (below). Separate water budgets will represent dry, wet, and average water years. The Big Lost River basin supports agricultural resources for the state and is a tributary basin to the Eastern Snake River Plain.



Big Lost River basin groundwater budget study.

Ultimate project goals are to characterize the basin hydrogeology, estimate groundwater underflow to the Idaho National Laboratory (INL), support calibration efforts by IDWR of the existing Eastern Snake Plain Aquifer Model, and provide data and interpretation for decision makers and water right accounting processes.

The IGS portion of the contract (lead by IDWR and in collaboration with USGS) totals $125,000 and spans a nearly three-year period (December 2018 through October 2021). The results of the groundwater budgets will be presented in a comprehensive USGS report.

In 2019, IGS published work authored by John H. Bush, Pamela Dunlap, and Stephen P. Reidel on stratigraphic relationships within the Columbia River Basalt Group (CRBG) in the Moscow-Pullman basin. This work includes field reconnaissance, compilation, review and interpretation of over 500 vicinity well logs, providing coordinate locations, completion details, and lithologic descriptions. Key hydrogeologic findings have implications for understanding groundwater recharge mechanisms to the sedimentary and CRBG aquifers utilized for water supply. Specifically, the results suggest:

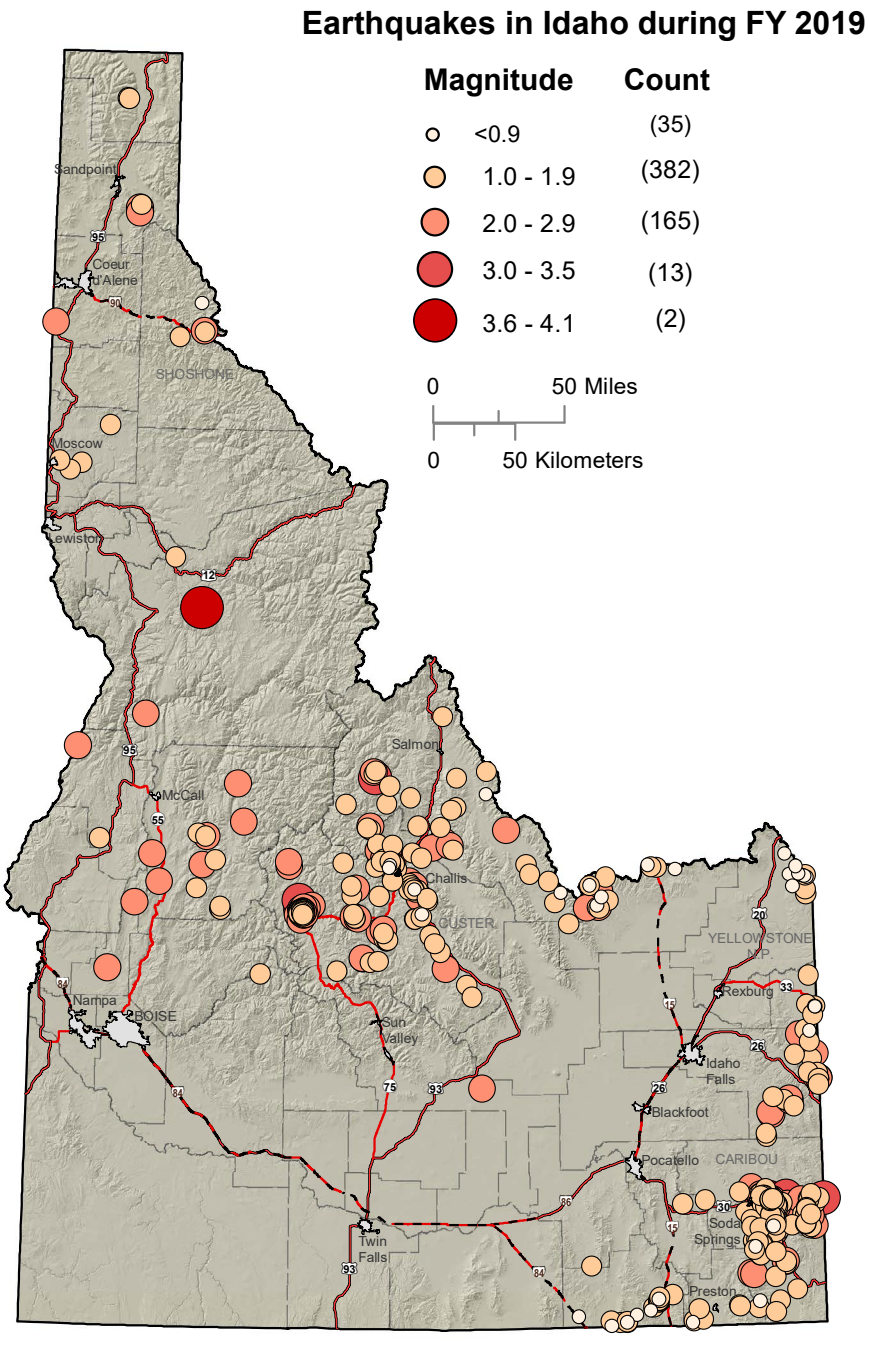
(1) Considerable modern recharge is reaching the upper aquifer system via sediments beyond the eastern extent of the Wanapum Basalt and recharge into the lower aquifer occurs along the western edges of the Palouse Range via coarse-grained channel sediments of the Latah Formation.

(2) Structural barriers to groundwater flow are present, including the basalt of Lolo as an aquitard preventing lower aquifer recharge over much of the Moscow-Pullman basin with possible exceptions in the Pullman area, and geologic structures form barriers to east-west movement of groundwater flow across the western edge of the Moscow-Pullman basin.

Geologic Hazards

Overview

Geologic hazards are natural or human-induced conditions that have the potential to pose a hazard to the natural or built environment. The wide variety of geologic, topographic, and climatic conditions in Idaho result in many geologic



Location and magnitude of earthquakes in Idaho during FY 2019.
Source: USGS-ANSS Comprehensive Earthquake Catalog for 07-01-2018 to 06-30-2019.

hazards across the state. Geologic hazards in Idaho include earthquakes, landslides, volcanic eruptions, expansive soils, sinkholes, ground surface subsidence, radon, and exposure of other hazardous minerals.

As the State's population continues to rapidly grow and infrastructure expands, the risk posed by geologic hazards, with associated losses and costs, increases. To help mitigate that risk, the IGS tracks, documents, and studies geologic hazards and supplies relevant hazard data to the public. IGS also provides expert opinion and advice to help mitigation efforts of other agencies. In FY 2019, IGS continued its geologic hazards program in several ways:

- Contribute to geological mapping through the USGS Statemap program to provide baseline information on the nature, location, size, and frequency of these hazards. This information may be incorporated into planning documents and serves as the basis for more detailed studies.
- Provide expert opinion and advice to state and federal agencies involved with Idaho hazard mitigation. This includes the Idaho Office of Emergency Management (IOEM) and FEMA. IGS staff provide input for the State Hazard Mitigation Plan and serve on IOEM's seismic technical working group.
- Conduct public education and outreach through publications, press releases, media interviews, social media, and public lectures.
- Participate in the Western States Seismic Policy Council (WSSPC). The WSSPC mission is to develop seismic policies and share information to promote programs that reduce earthquake-related losses.

Earthquakes

IGS stays informed about Idaho and important regional earthquakes through seismic monitoring performed by USGS, Montana Bureau of Mines and Geology, University of Utah, INL, and Pacific Northwest Seismic Network. When an earthquake occurs, its location, magnitude, and shaking intensity data are posted within minutes to the internet by the USGS.

While seismic activity in Idaho in FY 2019 was relatively low compared to recent years, there was continued seismic activity near Soda Springs and Challis. Over 200 earthquakes were recorded near Soda Springs during FY 2019, part of an ongoing earthquake sequence that started in September 2017 with a magnitude 5.3 earthquake. In FY 2019, approximately 70 earthquakes as

large as magnitude 3.4 were recorded near Challis. These earthquakes are part of a continuing earthquake swarm that has been occurring for several years. No damage from any of these earthquakes was reported.

Landslides

Landslides, debris flows, and alluvial fan floods occur frequently in Idaho's mountainous landscapes. Transportation networks such as highways and railroads are particularly vulnerable to these hazards since they are often located in narrow canyons along rivers and streams.

In FY 2019, several notable landslides occurred in Idaho. Heavy precipitation and snowmelt in March and April 2019 caused multiple landslides along:

- ID-55 between Banks and Smiths Ferry
- ID-11 and county roads near Greer
- US-12 between Kamiah and Greer
- ID-162 between Kamiah and Winona
- US-95 between Weiser and Midvale

In FY 2019, the Survey continued work on a pilot project to map landslides along transportation corridors in the Panhandle region, in response to landslide activity in FY 2017. IGS staff collaborated with Idaho State University faculty to map areas of concern with a lidar instrument mounted on an unmanned aircraft system (UAS).

The Survey is continuing work on a new digital landslide database, partially funded by a two-year grant from the Idaho Transportation Department (ITD). The database is an inventory of known landslides, compiled from multiple sources, including IGS mapping, student theses, ITD records, and federal agency reports.

Volcanic Eruptions

The Survey collaborates with monitoring of regional volcanic activity as a member of the Yellowstone Volcano Observatory (YVO) consortium. YVO members consist of the USGS, Yellowstone National Park, UNAVCO, University of Utah, University of Wyoming, and the geological surveys of Idaho, Wyoming, and Montana.

In FY 2019, no volcanic eruptions occurred in Idaho. However, normal levels of seismicity related to Yellowstone volcanic activity occurred throughout FY 2019.

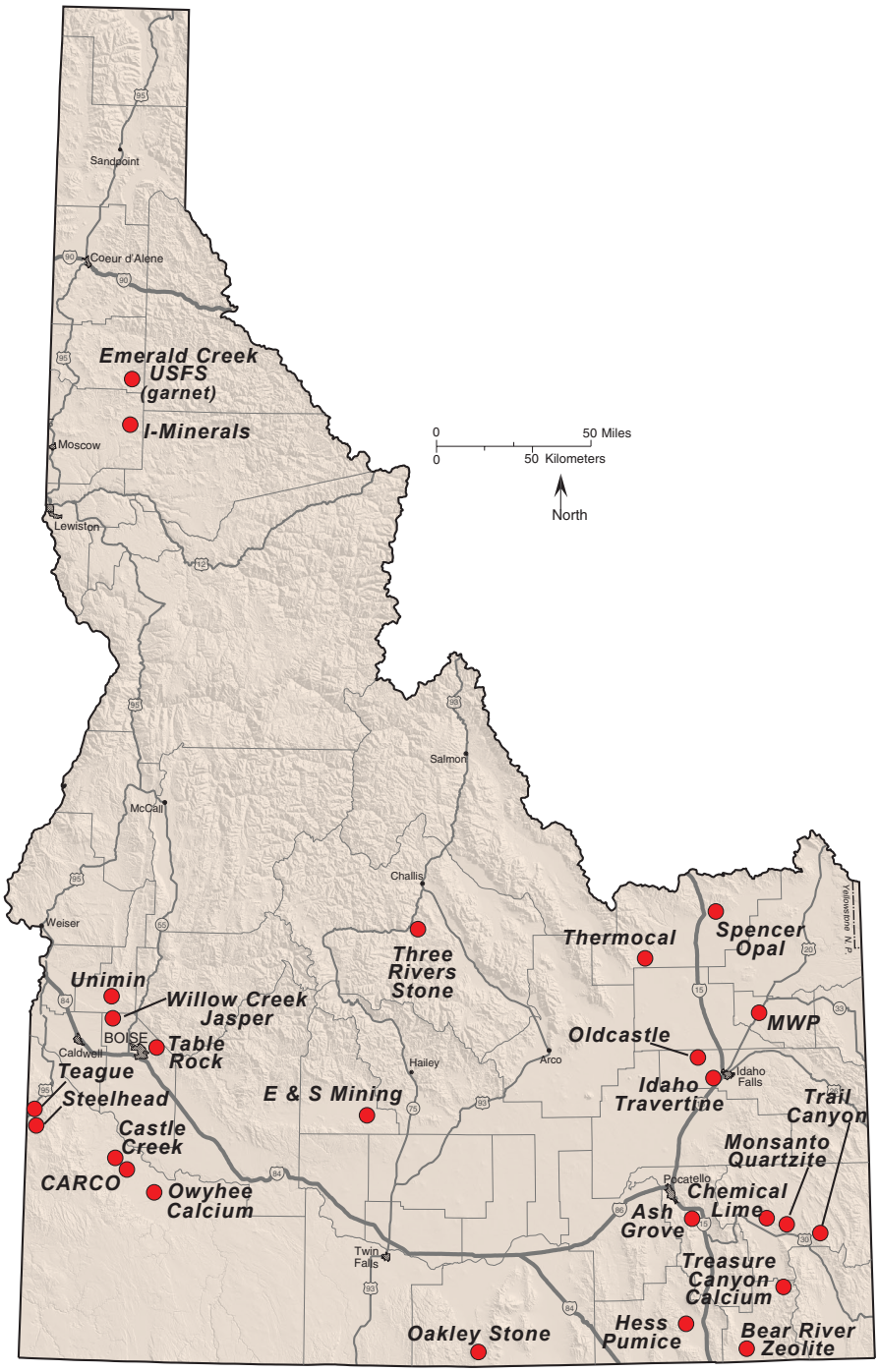
In the event of volcanic ash eruptions from Cascade volcanoes, the Survey will collaborate with the USGS Cascade Volcano Observatory (CVO). Volcanoes in Idaho other than Yellowstone are covered by the CVO. In FY 2019, IGS staff visited CVO in Vancouver, WA to present a talk about Idaho geologic hazards and to coordinate with CVO staff on volcano monitoring. This resulted in a revised Eruption Communication Plan aimed at streamlining communication between agencies in the event of a volcanic eruption.

Mineral Resources and Mining

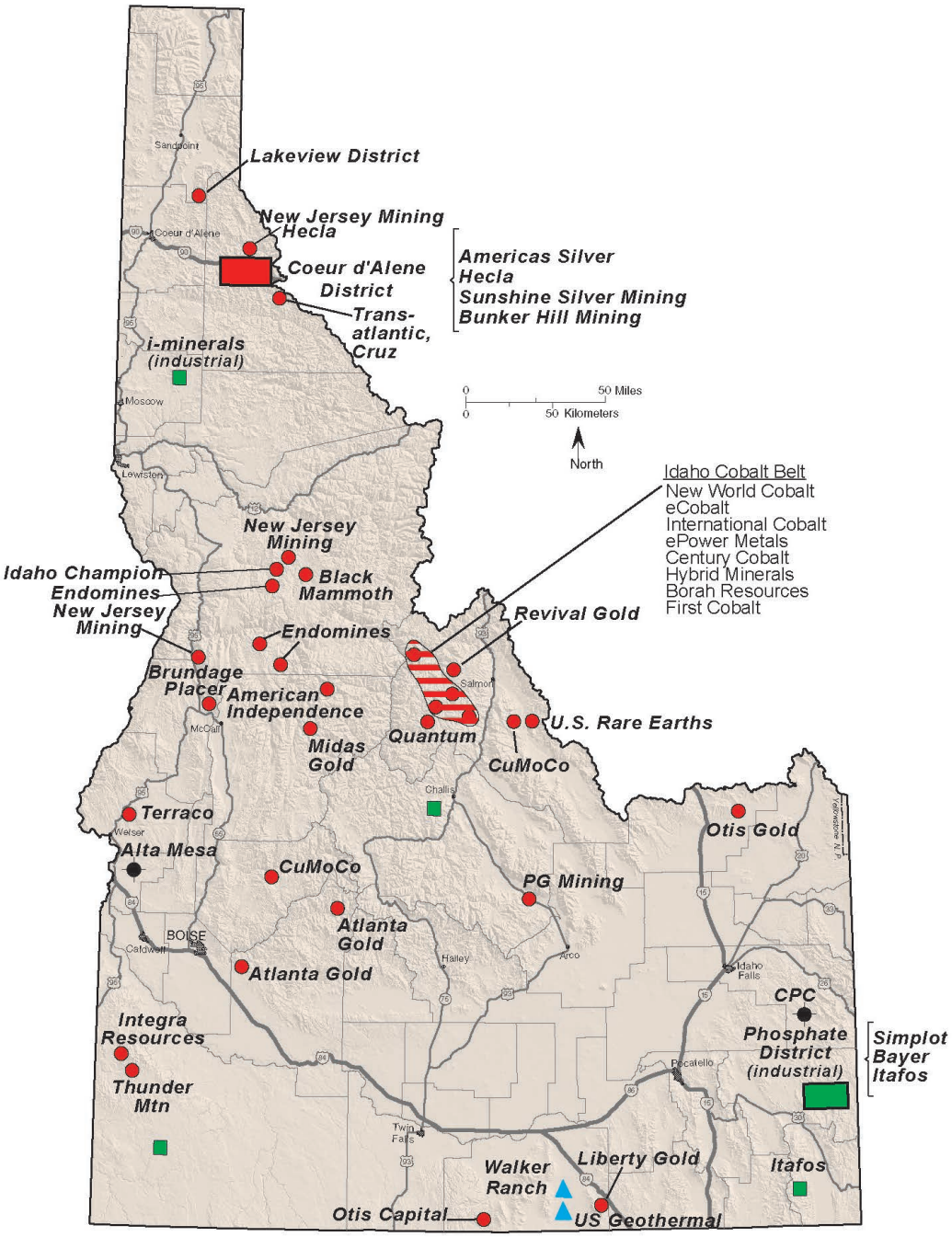
Active Mining and Exploration

In FY 2019 the IGS continued its history and statutory responsibility of preparing an annual update on Idaho's mining and exploration industry. IGS is the lead state agency for mineral research and compiling, disseminating, and archiving information on the state's mineral resources. Through a collaboration with the USGS, Idaho's information is part of the Idaho chapter of the Minerals Yearbook, a global compilation of developments and statistics on mining and minerals. This year, an overview of Idaho's minerals activity in 2018 was part of the inaugural Idaho Mining Conference in November in Boise. In December, the minerals activity summary for calendar year 2018 was presented at the American Exploration and Mining Association (AEMA) annual convention in Spokane. Exploration was especially active in the Idaho Cobalt Belt in 2018 due to the metal's increasing importance and use in battery technology. Much of the Idaho Cobalt Belt in Lemhi County was staked, and there were two advanced exploration/development projects and a number of grassroots efforts active during the 2018 field season.

The USGS estimate of statewide nonfuel mineral production for Idaho in 2018 is not yet available, due in part to federal changes in reporting. However, principal commodities mined included phosphate rock, construction sand, gravel and crushed stone, lime, silver, and lead. Three large phosphate mines continued operations in Caribou County with some name changes. Bayer bought Monsanto, including its phosphate business, and Agrium sold their operations to Itafos. Americas Silver Corporation mined silver and lead at the underground Galena mine in Shoshone County. Hecla's Lucky Friday mine remained on



Industrial mineral operations active during calendar year 2018.



Mineral exploration activity during calendar year 2018. Red symbols represent metals; green symbols represent industrial minerals; blue symbols represent geothermal; black symbols represent oil and gas.

strike. At Murray, New Jersey Mining operated the Golden Chest gold mine from both underground and the open pit. The Thompson Creek molybdenum mine remained on care and maintenance with minor toll milling taking place. Endomines, a Finnish company was developing and then opened a small underground gold mine near Elk City in Idaho County. There was little change in the many small industrial minerals operations from the previous year.

Exploration activity in calendar year 2018 was robust in Idaho, but by the first half of 2019, a slight slowdown was evident. Midas Gold continued the NEPA permitting process with the USFS for development of a new gold-antimony mine in Valley County at the historic Stibnite district. Major drill programs for precious metals included a very large effort by Revival Gold at the Beartrack mine in Lemhi County and drilling by Integra Resources at the old De Lamar mine in Owyhee County. Gold exploration was also underway near Elk City, Murray, and the old Black Pine mine in southeastern Idaho, and copper was the primary target by PG Mining at the Empire mine. In the Idaho Cobalt Belt, eCobalt was constructing facilities and optimizing engineering and processing plans for a new cobalt-copper-gold mine at the RAM deposit on the periphery of the Blackbird mining district. First Cobalt was drilling from underground and surface at the Iron Creek property on the southeast end of the cobalt belt. At least four other companies had claims and projects along the belt during 2018.

Minerals-Related Research

There were two major minerals-related research projects underway in FY 2019. The first project was preparation of an IGS publication documenting the geochronology and hydrothermal alteration studies at the Stibnite Au-Sb-W deposits in Valley County. IGS Bulletin 31, *Geology and Temporal Evolution of Alteration and Au-Sb-W Mineralization, Stibnite Mining District, Idaho*, was published in March 2019. In addition to 149 pages, it includes seven digital appendices. The publication is available for free download on the IGS website. An August 2018, field trip to Stibnite with the USGS and other researchers helped plan for an article in a peer-reviewed journal. The research resulted from a collaborative project with Midas Gold at the historic mining district, also known as the Yellow Pine district. The multi-faceted research included field studies, petrography, age determinations, isotopic, and microprobe analytical work. Geoscientists at Boise State University, University of Alaska, Fairbanks, Midas Gold, and USGS are collaborators.

De Lamar mine, June, 2019. IGS geologists (D. Feeney and K. Schmidt) getting an orientation tour from former De Lamar mine geologist Kim Richardson (back to camera).

A new minerals research project started in FY 2019 with a proposal in the first half of 2019 to Integra Resources Corporation who is exploring the De Lamar and Florida Mountain gold-silver deposits in Owyhee County. The project, funded by Integra Resources, is for two geologic maps of the 7.5′ De Lamar and Swisher Mountain quadrangles. Field work began by the end of FY 2019 and will continue into FY 2020. Funding for petrography, geochemical analyses of the volcanic rocks, and some geochronology are also included. The two geologic maps will be published by the Survey.

Energy

Geothermal

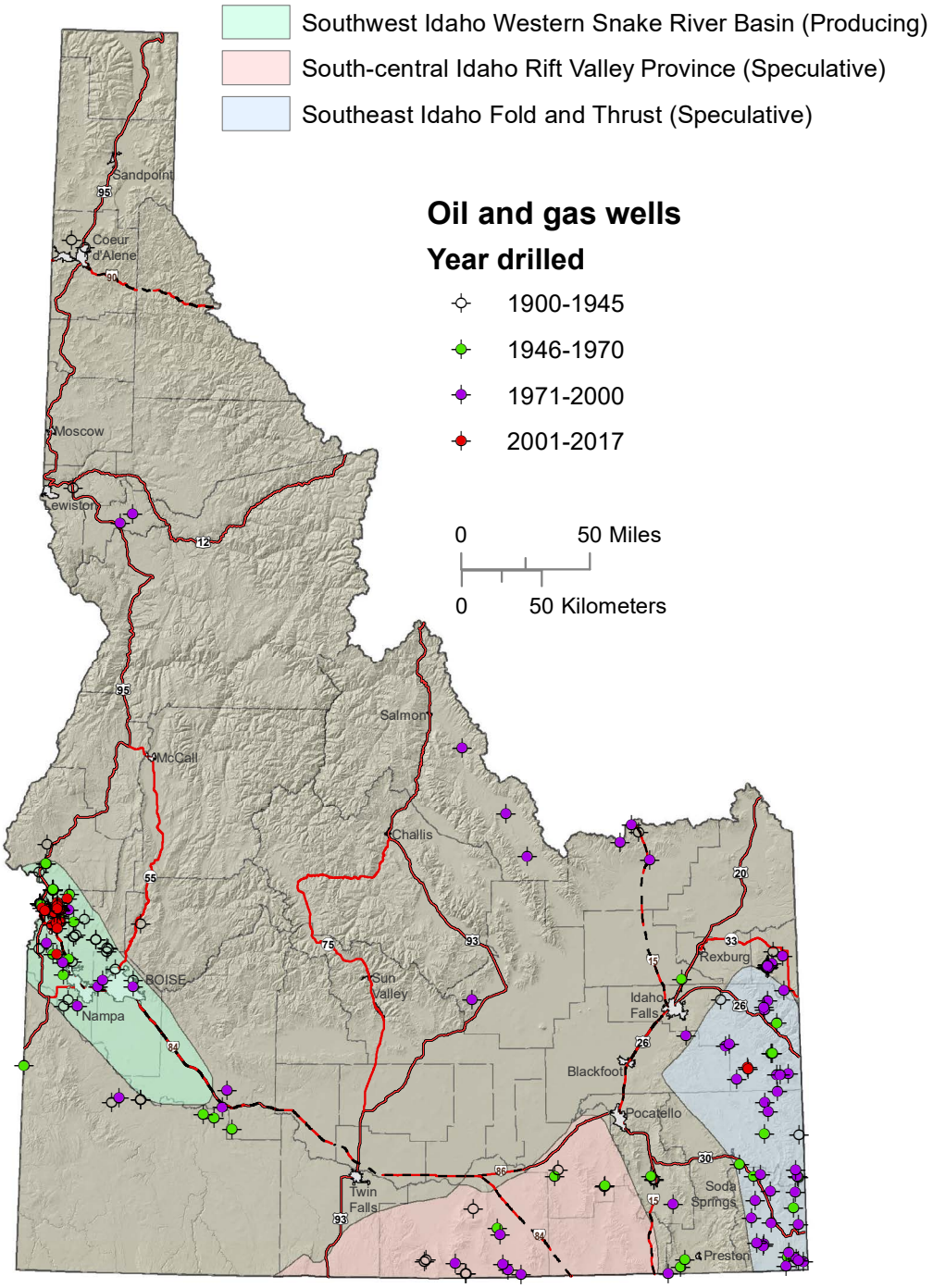
IGS participated in Valley County Geothermal Working Group meetings held in Cascade, Idaho, during May and June 2019. Cascade resides within the Cretaceous Idaho Batholith in a structural basin formed by bounding faults and fractures that serve as conduits for geothermal fluids. The Cascade School District and community swimming pool currently utilize geothermal heating, and several thermal springs are used in the area for recreation. The working group focuses on promoting and evaluating sustainable development of geothermal resources near Cascade, requiring technical, regulatory, and funding considerations. Some additional potential uses being considered include power generation (dependent on the resource temperature), district heating, greenhouses and aquaculture, expanded recreation, and secondary uses for geothermal fluids.

Oil and Gas

The purpose of the oil and gas program at IGS is to advance the understanding of petroleum resources in Idaho in a manner that enables exploration and development in an economically efficient and socially responsible fashion. We achieve this through:

- Conducting primary research on the formation and occurrence of proven and possible petroleum systems.
- Preparing assessments on the hydrocarbon potential of select geologic provinces.
- Storing, archiving, and disseminating a wide variety of subsurface geological data.
- Transferring knowledge and information to operators, scientists, policy makers, and the public.

In 2015, Idaho became the nation's 31st hydrocarbon producing state when commercial quantities of gas, liquid condensate, and oil were discovered and produced from wells in the Western Snake River Plain region of southwestern Idaho. Since then, Idaho has produced approximately 800,000 barrels of condensate/oil and more than 10 billion cubic feet of natural gas. The exploration and development of energy resources like petroleum benefit the state and its citizens by adding revenue to the state economy and through direct payments associated with lease bonuses, production royalties, and severance taxes. The



Oil and gas well locations in Idaho, producing and potential oil and gas basins.

Western Snake River Plain (WSRP) of southwestern Idaho represents an emerging oil and gas producing region with upside potential; however, ongoing exploration and development is hampered by limited knowledge on the geologic framework and associated petroleum system. Collaboration and research agreements between public and private entities (IDL and Alta Mesa Holdings) have permitted the Survey to acquire subsurface data, sample producing wells, and begin the process of evaluating the hydrocarbon potential of the region. Current research is focused on characterizing the basin fill and associated petroleum system elements including the origin of produced hydrocarbons. Research efforts in FY 2019 allowed for progress in:

- Understanding the stratigraphic framework of the basin fill and its evolution through time through integration of seismic, well, and field mapping data.

- Characterizing the size and internal complexity of producing reservoirs in the WSRP by combining information from 2D seismic images of the subsurface with drone imagery from outcrop analogs.

- Evaluating the character and distribution of potential source rocks and produced gas and fluids.

In addition to the WSRP, there are other poorly explored areas in Idaho which presently are nonproducing but have many geologic characteristics in common with productive basins elsewhere and may represent a part of future oil and gas production within the state. The IGS has identified the areas of south-central and southeastern Idaho as perspective for oil and gas exploration and have near-term and long-term plans to conduct petroleum assessments in these regions of the state. The southeast Idaho play is an extension of the Fold and Thrust which is a proven play in southwest Wyoming. The south-central play is highly speculative and defined by the association of several large structures and well-known Paleozoic source rocks. No prospects have been tested. Collaboration between IGS, Cedar Creek Resources, and Western State Colorado University are now in place to gain further subsurface information to study these potential petroleum systems.

In conjunction, new geologic surface mapping projects conducted by the IGS are underway in the southwest Idaho (Weiser-Payette area) and southeast Idaho that augment nearby subsurface evaluations. Surface mapping projects are providing age constraints needed to properly assess the basin evolution and information on structural and stratigraphic relationships that are difficult

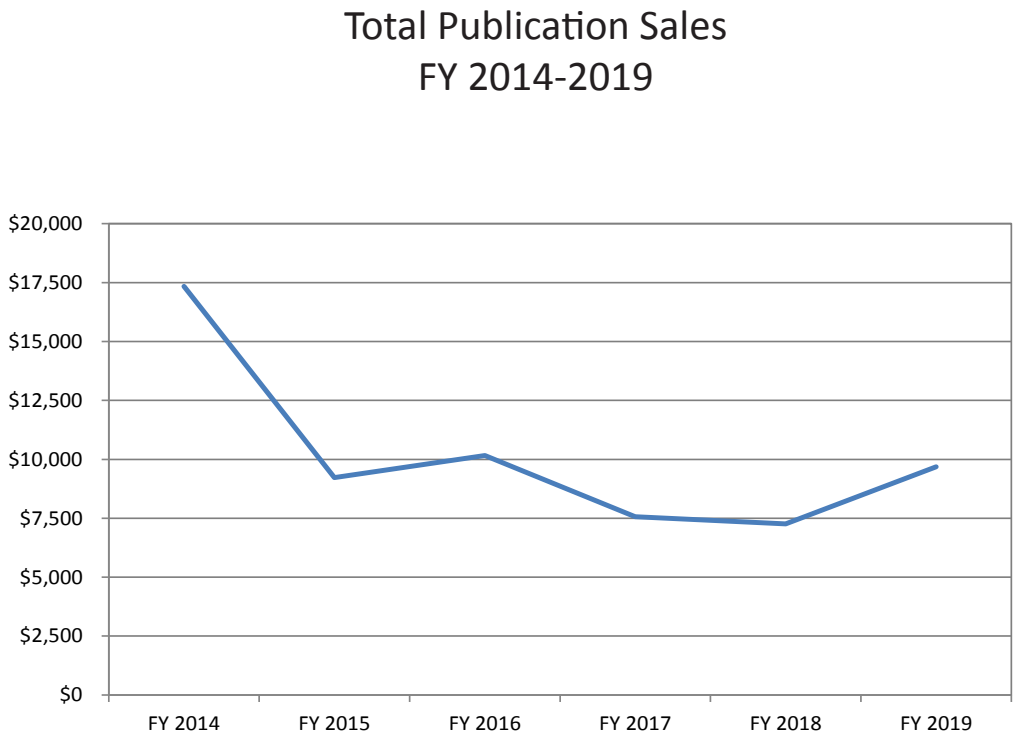
to evaluate with subsurface data alone. In addition, research in the oil and gas program is supported by several million dollars in petroleum modeling software (Schlumberger's Petrel Exploration & Production Platform, Schlumberger's PetroMod Petroleum Systems Modeling Software, IHS's Petra, and SMT's Kingdom Geological Interpretation Software) made available to the Survey and the University of Idaho from industry partnerships. IGS research into the subsurface geology of poorly understood basins also has the potential to benefit non-petroleum related activities such as geothermal energy, natural gas storage, carbon sequestration, and the development of deep groundwater resources.

OUTREACH

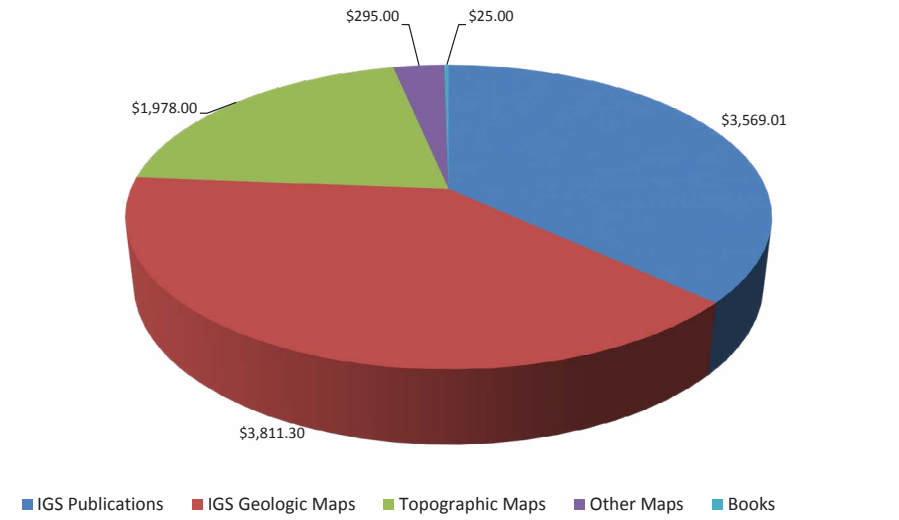
The Survey disseminates geologic data on Idaho primarily through IGS publications, the agency website, social media, in-house collections, and efforts by the staff to educate the public in the earth sciences.

Publications

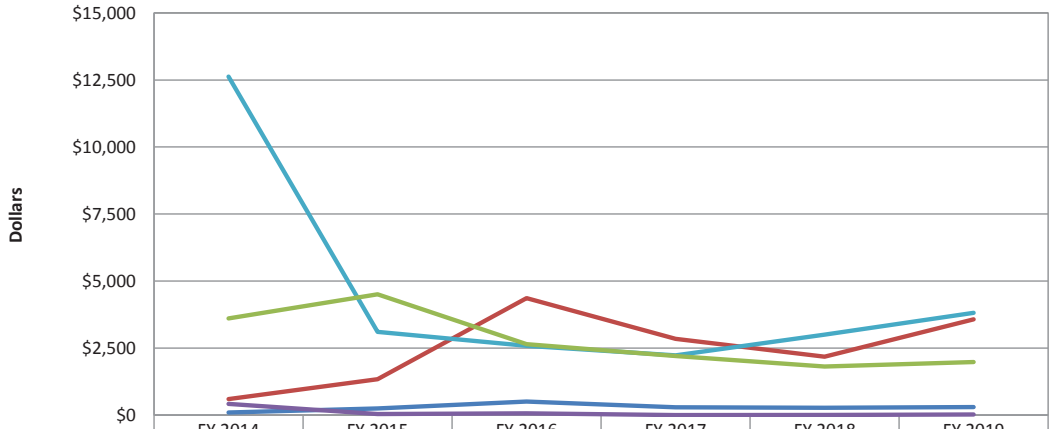
In FY 2019 publication sales increased by 33% from the previous year. IGS Geologic Maps outsold other types of publications, accounting for 39% of total sales in FY 2019. Since its release in 2012, *Geologic Map of Idaho* (Map 9) has continued to be the best seller of IGS-produced publications. Nearly all publications are available for free download on the IGS website.



Publication Sales by Sales Category
FY 2019



Publications Sales by Sales Category
FY 2014-2019



	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
IGS Publications	$596	$1,334	$4,362	$2,840	$2,176	$3,569
IGS Geologic Maps	$12,626	$3,107	$2,585	$2,227	$3,000	$3,811
Topographic Maps	$3,602	$4,505	$2,644	$2,203	$1,811	$1,978
Other Maps	$96	$250	$504	$294	$270	$295
Books	$418	$35	$63	$0	$4	$25

Website

www.idahogeology.org

The IGS website provides the public easy access to agency publications and data. Nearly all of Survey publications (over 980) are available for download at no cost. IGS also offers interactive web map applications to search, locate, and download documents and data. Thousands of additional mine documents were added to the Mines web application in FY 2019. The Geochem web application was redesigned to expand online queries, present expanded web tables, and deliver user-queried data as a single CSV (Comma Separated Values) file. In FY 2019 more than 400,000 visits were logged on the website. Eleven new Survey publications were posted on the website this year which include geologic maps, GIS geodatabases, digital analytical datasets, technical reports, staff reports, and bulletins.

Social Media

The IGS has maintained a social media presence on Facebook and Twitter (@IDGeoSurvey) since December 2013. Social Media gives IGS the ability to reach a broader, nontraditional audience. IGS uses social media to announce new IGS publications; give details on statewide geology-related activities, hazards, warnings, and drills; post general geoscience information; and post job announcements. In FY 2019 our Facebook posts reached over 1,280 Facebook users. IGS tweeted 33 times and currently has 1,373 followers on Twitter.

Digital Mapping and GIS Laboratory

The Survey's digital mapping and GIS laboratory provides services that include digital cartography, spatial data management, database management and design, network system administration, graphic design, desktop publishing, and website support. Five 7.5′ geologic maps were digitized, and one geologic map was published this fiscal year. Published maps and databases are available as printed products or for download on the IGS website. The lab continues to compile geology from around the state in geologic map databases to meet compliance with the USGS Geologic Map Schema (GeMS). The lab also participated in the Macrostrat Project, contributing seven 30′ x 60′ quadrangle databases to the collaborative worldwide geologic data platform.

This fiscal year IGS was granted two local area networks (LANs) separate from the University network that are joined as an Intranet enabling direct communication between the servers and workstations with no offsite routing. The LANs were necessary to stabilize mapped drives, prevent errors when saving large datasets, allow the servers full control of the workstations, guarantee security for proprietary and confidential data from industry and research partners, and improve productivity.

Databases and Archives

Database management and updates of active faults, mines and prospects, oil and gas wells, and geologic maps are a continuing effort. The databases are distributed to the public via the agency website.

- The Mines and Prospects database underwent operational improvements, as well as continued efforts to expand content and improve accuracy. In preparation for a concerted effort to review references concerning rare earth elements, a revision of data entry workflow was devised and implemented. Records for five hours of audio-visual footage were added, with links to downloadable files, including hyperlinks to view the 44 geo-located video clips via YouTube. The main access to Mines and Prospects data is via the Mines web application. Over 15,200 mine maps, unpublished reports, documents, and other mining-related media are now available for download through this web application.
- The Geochem database and web application were modified to include inductively coupled mass spectrometry, instrumental neutron activation analysis, and other analyses in addition to existing X-ray fluorescence data. A streamlined workflow for incorporating future digital analytical data (DAD) records was also implemented. All new and previous DAD publications were revisited and harvested for this expanded inclusion. The Geochem web application was redesigned to:
    - Expand online queries by spatial, unit, lithologic, and age filters
    - Present expanded web tables to accommodate additional analyses
    - Deliver user-queried data as a single CSV file for incorporation with a variety of analytic software and database management systems

- One GIS geodatabase in close compliance with USGS GeMS was published in FY 2019.
- The Oil and Gas database is undergoing update and revision in concert with IDL, in order to resolve location accuracy and completeness of record. The database includes about 200 oil and gas exploration wells in the state and records for each well include geophysical logs, well reports, drilling correspondences, permits and applications, industry reports, and maps that date from 1903 to 2017. All historic (pre-2000) oil and gas documents and logs have been scanned and are available from the IGS website through the Oil & Gas web application. In addition to oil and gas documents the survey maintains a physical collection of selected well cuttings and cores that are available for examination. As other historic and contemporary reports and samples become available, IGS continues to enhance and expand the oil and gas archive geodatabase. The oil and gas database is an important source of geologic and engineering information regarding exploration for, and development of, oil and natural gas, water, coal, groundwater, and geothermal resources.

Earth Science Education

The IGS seeks to promote excellence in the teaching and practice of the earth sciences. Every October the IGS participates in the American Geosciences Institute (AGI) sponsored Earth Science Week. Earth Science Week is a chance for AGI, in cooperation with its partners, to help build a better understanding and appreciation of the earth sciences by delivering specially designed activities and resources to educators. The IGS received 50 Earth Science Week Toolkits, and as part of a broader, long-term approach to earth science outreach, kits were distributed to earth science and physical science teachers in southeast Idaho. The IGS participated in the "Geologic Map Day" event during Earth Science Week by highlighting the recently published *Geologic Map of the Northeast Emmett Quadrangle, Gem County, Idaho* on the IGS website and social media. In 2018 the IGS partnered with other state and federal agencies in support of "The Great Idaho ShakeOut", a statewide earthquake drill which encourages Idahoans to prepare for major earthquakes. We are increasing our outreach with a dedicated email and mailing list to provide earth science information to earth science and physical science teachers. The IGS also gives educational presentations, participates in outreach events statewide, and prepares outreach materials which are listed below.

An Overview of Oil and Gas Development in the State of Idaho, by Mark Barton: Boise Southwest Rotary Club, Boise, March 2019.

An Overview of the Idaho Geological Survey, by Michael E. Ratchford: Idaho Youth ChalleNGe Academy Job Fair, Pierce, November 2018.

An Overview of the Idaho Geological Survey, by Michael E. Ratchford: Idaho Youth ChalleNGe Academy Job Fair, Pierce, May 2019.

Craters of the Moon: Idaho's last (and next?) volcanic eruption, by Zach Lifton: Yellowstone Volcano Observatory Caldera Chronicles, February 2019.

Forestry Field Course, by Zach Lifton: University of Idaho, McCall, May 2019.

Geologic Hazards in Idaho, by Zach Lifton: Boise Southwest Rotary Club, Boise, March 2019.

Geology of Bear Lake Area, Idaho, by Dennis M. Feeney: 4-H University of Idaho Bear Lake Extension, Montpelier, July 2018.

Idaho Geological Survey Exhibit, by Alexis Clark: 2019 Air National Guard Gowen Summer STEM Camp, Boise, June 2019.

Idaho Geological Survey Exhibit, by Alexis Clark: Idaho Science Teachers Association and Idaho Council of Teachers of Mathematics Annual Conference, Eagle, October 2018.

Idaho Geological Survey Exhibit, by Christopher A. Tate, Reed S. Lewis, and Dennis M. Feeney: Hells Canyon Gem Club 52nd Annual Gem, Minerals, and Jewelry Show, Lewiston, October 2018.

Idaho Geological Survey Exhibit, by Mark Barton, Alexis Clark, Virginia Gillerman, and Zach Lifton: Idaho Gem and Mineral Show, Boise, February 2019.

Idaho Geological Survey: Overview of Idaho's Hydrogeology, by Alexis Clark: Boise Southwest Rotary Club, Boise, March 2019.

Idaho Geology and Gems, by Virginia S. Gillerman: City of Boise eARTworks Class, Boise, November 2018.

Idaho Ore Deposits, by Reed S. Lewis: Resources Class, Department of Geological Sciences, University of Idaho, Moscow, November 2018.

Mining in Idaho: Then and Now, by Virginia S. Gillerman: Southwest Rotary Club of Boise, Boise, March 2019.

University of Idaho IDRONE Student Camp, by Zach Lifton: University of Idaho, Boise, June 2019.

PUBLICATIONS AND ACTIVITIES

Publications

Database of the Mines and Prospects of Idaho (version 1.2018.1), by Christopher A. Tate, Victoria E. Mitchell, and Loudon R. Stanford: Idaho Geological Survey Digital Database 1, 2018.

Geologic Cross Sections Across the Moscow-Pullman Basin, Idaho and Washington, by John H. Bush, Pamela Dunlap, Stephen P. Reidel, and Daisuke Kobayashi: Idaho Geological Survey Technical Report 18-1, scale 1:24,000, 2018.

Geologic Interpretations of Well and Important Rock Outcrops in The Moscow-Pullman Basin and Vicinity, Idaho and Washington, by John H. Bush and Pamela Dunlap: Idaho Geological Survey Technical Report 18-4, 2018.

Geologic Map of the Hawley Gulch Quadrangle, Bonneville and Madison Counties, Idaho, by William M. Phillips, Renee L. Love, and Dennis M. Feeney: Idaho Geological Survey Digital Web Map 186, scale 1:24,000, 2019.

Geology and Temporal Evolution of Alteration and Au-Sb-W Mineralization, Stibnite Mining District, Idaho, by Virginia S. Gillerman, Mark D. Schmitz, Jeff A. Benowitz, and Paul W. Layer: Idaho Geological Survey Bulletin 31, 2019.

GIS Geodatabase for the Geologic Map of Hawley Gulch Quadrangle, Bonneville and Madison Counties, Idaho, by Claudio Berti, Linda Tedrow, and Jonathan Sandquist: Idaho Geological Survey Digital Web Map (GIS) 186, 2019.

Idaho Mining: A 2018 Summary of Trends and Potential, by Virginia S. Gillerman: Mine Idaho, p. 24-26, 2019.

Major-oxide and Trace-element Analyses of Igneous Rock Samples from Southwest Idaho, 1970-2002, by Dennis M. Feeney, Bill Bonnichsen, Adam N. Price, and Megan M. Aunan: Idaho Geological Survey Digital Analytical Data 16, 2018.

Miocene Evolution of the Moscow-Pullman Basin, Idaho and Washington, by John H. Bush, Pamela Dunlap, and Stephen P. Reidel: Idaho Geological Survey Technical Report 18-3, 2018.

Site Inspection Report for the Abandoned and Inactive Mines in Idaho on U.S. Forest Service Lands (Region 4), Boise National Forest: Volume I: Atlanta Area, Elmore County, Idaho, by John D. Kauffman, Ted Erdman, Earl H. Bennett, and Victoria E. Mitchell: Staff Report 19-01, 2019.

Structure Contours on the Top of the Grande Ronde Basalt in the Moscow- Pullman Basin and Vicinity, Idaho and Washington, by John H. Bush and Pamela Dunlap: Idaho Geological Survey Technical Report 18-2, scale 1:62,500, 2018.

Reports

Abandoned Mine Lands Work Progress Report, by Reed Lewis and Christopher Tate: Idaho Department of Lands Task Order 4, November 2018.

Collection of annual mining industry reviews from Idaho, by Christopher Tate: Deliverable to the U.S. Geological Survey for National Geological and Geophysical Data Preservation Program, July 2018.

Collection of geochemical data (database/interactive app) from Idaho, by Christopher Tate: Deliverable to the U.S. Geological Survey for National Geological and Geophysical Data Preservation Program, July 2018.

Collection of Mineral Property Files from Idaho, by Christopher Tate: Deliverable to the U.S. Geological Survey for National Geological and Geophysical Data Preservation Program, August 2018.

Collection of Mines and Prospects Web Application from Idaho, by Christopher Tate: Deliverable to the U.S. Geological Survey for National Geological and Geophysical Data Preservation Program, July 2018.

Collection of Mines and Prospects Database from Idaho, by Christopher Tate: Deliverable to the U.S. Geological Survey for National Geological and Geophysical Data Preservation Program, August 2018.

Geologic Map of the Border Quadrangle, Bear Lake County, Idaho, and Lincoln County, Wyoming, by James C. Coogan, Skye W. Cooley, David E. Stewart, and Dennis M. Feeney: Deliverable to the U.S. Geological Survey for Statemap Program, scale 1:24,000, June 2019.

Geologic Map of the Hanover Mountain Quadrangle, Idaho County, *Idaho*, by Reed S. Lewis, David E. Stewart, Eric D. Stewart, Loudon R. Stanford, Russell F. Burmester, and Keegan L. Schmidt: Deliverable to the U.S. Geological Survey for Statemap Program, scale 1:24,000, June 2019.

Geologic Map of the Pegram Quadrangle, Bear Lake County, Idaho, by James C. Coogan, Dennis M. Feeney, and Skye W. Cooley: Deliverable to the U.S. Geological Survey for Statemap Program, scale 1:24,000, June 2019.

Geologic Map of the Weiser North Quadrangle, Washington County, Idaho, by Dennis M. Feeney, Reed S. Lewis, Loudon R. Stanford, and Kurt L. Othberg: Deliverable to the U.S. Geological Survey for Statemap Program, scale 1:24,000, June 2019.

Geologic Map of the Ulysses Mountain Quadrangle, Lemhi County, Idaho, by Reed S. Lewis, Russell F. Burmester, and Jeffrey D. Lonn: Deliverable to the U.S. Geological Survey for Statemap Program, scale 1:24,000, June 2019.

Idaho Geological Survey Minerals Information for Proposed Salmon-Challis Forest Plan Revision with Wilderness Evaluation Areas, by Virginia S. Gillerman and Claudio Berti: Idaho Geological Survey memo to U.S. Forest Service and Idaho Office of Energy and Mineral Resources, February 2019.

National Geological and Geophysical Data Preservation Program Final Technical Report, by Reed Lewis, Christopher Tate, and Dennis Feeney: Deliverable to the U.S. Geological Survey for Data Preservation 10, October 2018.

Presentations

An Overview of Idaho's Oil and Gas Plays, by Mark Barton: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

A Peek into the Petroleum Geology of Idaho's Southwest Oil and Gas play; Basin Architecture and Petroleum systems, by Mark Barton: Idaho Association of Professional Geologists Meeting, Boise, December 2018.

Brief Overview of Geologic Mapping and Geologic Hazards in Idaho, by Peter Isaacson: Association of American State Geologist, Butte, Montana, June 2019.

Economic Geology: Stibnite Project, by Virginia S. Gillerman: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Geologic Hazards in Idaho, by Zach Lifton: 1st Annual American Society of Civil Engineers (ASCE) Idaho Civil Engineering Conference, Boise, March 2019.

Geologic Hazards in Idaho, by Zach Lifton: Cascade Volcano Observatory Seminar Talk, Vancouver, Washington, April 2019.

Geologic Hazards in Idaho, by Zach Lifton: East Idaho Regional Local Emergency Planning Committee and Eastern Idaho Healthcare Coalition Meeting, Rexburg, May 2019.

Geologic Hazards in Idaho, by Zach Lifton: Idaho Association of Professional Geologists Meeting, Boise, November 2018.

Geologic Mapping as It Relates to Mineral and Hydrocarbon Exploration in Idaho, by Reed S. Lewis: Coeur d'Alene Chapter, Society for Mining, Metallurgy, and Exploration, Kellogg, October 2018.

Geologic Mapping in Southeast Idaho, by Dennis M. Feeney: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Geologic Mapping in the Miocene Weiser Volcanics; Idaho's Full-suite Volcanic Field in Columbia River Basalt Country, by Dennis M. Feeney: University of Idaho and Washington State University Geoscience Seminar Series, Moscow, March 2019.

Geology and Temporal Evolution of Au-Sb-W Mineralization, Stibnite Mining District, Idaho, by Virginia S. Gillerman: Midas Gold, U.S. Geological Survey, Idaho Geological Survey, University of Nevada Reno Field Trip, Stibnite, August 2018.

Idaho Earthquakes and Active Faults, by Zach Lifton: Basin and Range Province Earthquake Working Group, Salt Lake City, Utah, February 2019.

Idaho Geological Survey Financial Overview, by John Brabb: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Idaho Geological Survey Financial Overview, by John Brabb and Peter Isaacson: Joint Finance-Appropriations Committee, Boise, March 2019.

Idaho Mining and Exploration, 2018, by Virginia S. Gillerman: American Exploration and Mining Association Annual Meeting, Spokane, Washington, December 2018.

IGS Hydrogeology Overview, by Alexis Clark: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Map Blast: Recent IGS Mapping Efforts, by Dennis M. Feeney and Linda A. Tedrow: Digital Mapping Techniques Workshop, Butte, Montana, May 2019.

Neogene Lacustrine Systems and Sequence Stratigraphy of the Western Snake River Basin, by Mark Barton: University of Idaho and Washington State University Geoscience Seminar Series, Moscow, April 2019.

Non-traditional (Biological) Applications for Geologic Maps, by Reed S. Lewis: Northwest Science Association 90th Annual Meeting, Lewiston, March 2019.

Overview of Idaho Mining and Exploration Trends – 2018, by Virginia S. Gillerman: Idaho Mining Conference, Boise, November 2018.

Overview of the Idaho Geological Survey, by John Brabb and Peter Isaacson: Governor's Office and Division of Financial Management, Boise, June 2019.

Overview of the Idaho Geological Survey, by Peter Isaacson: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Overview of the IGS Geologic Hazards Program, by Zach Lifton: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Petroleum Geology of Idaho Southwestern Oil and Gas Play, by Mark Barton, Idaho Oil and Gas Commission, Boise, February 2019.

Play System Elements of the Western Snake River Plain, by Mark Barton: Hydrocarbon exploration and development industry representatives in the Western Snake River Basin, Idaho. Boise, April 2019

Successes in Leveraging Nontraditional Funding for Support of Geologic Mapping, by Dennis M. Feeney: Digital Mapping Techniques Workshop, Butte, Montana, May 2019.

Update on Geological Mapping and Data Preservation in Idaho, by Reed Lewis: Idaho Geological Survey Advisory Board Meeting, Boise, November 2018.

Web Products

Current Mining Activity, Regional Development Presentations 2018, by Virginia S. Gillerman and Christopher Tate: Idaho Geological Survey Website Update, February 2019.

Earthquake Occurrence in Southeast Idaho, Seismic Hazard Factsheet, by Earthquake Engineering Research Institute, Idaho Office of Emergency Management, and Idaho Seismic Technical Working: Idaho Office of Emergency Management and the Earthquake Engineering Research Institute, February 2019.

Geochem Web Application, by Christopher A. Tate, Dustin Thomas, Dennis Feeney, and Reed Lewis: Idaho Geological Survey, July 2018.

Mines Web Application, by Christopher A. Tate, Reed S. Lewis, and Dustin Thomas: Idaho Geological Survey, September 2018.

Operational Improvements

Cross-browser PDF Delivery, by Christopher Tate and Dustin Thomas: Idaho Geological Survey, September 2018.

Database of Geochemistry Major Oxide and Trace Element Analyses for Rock Samples from Idaho, by Dennis M. Feeney, Reed S. Lewis, and Christopher A. Tate: Idaho Geological Survey, 2018.

Database of the Mines and Prospects of Idaho version 1.2018.1, by Christopher Tate: Idaho Geological Survey, December 2018.

Idaho Active Claims GIS Map, by Christopher Tate: Idaho Geological Survey, October 2018.

Idaho Post-Earthquake Clearinghouse Operations Plan, by Zach Lifton, Idaho Office of Emergency Management, and the Earthquake Engineering Research Institute: Idaho Office of Emergency Management, May 2019.

Media Interviews

S*tatus of Idaho Mineral Activity*, Idaho Investment Guide, November 2018 interview for 2019 Edition, Volume 2, https://siteselection.com/cc/idaho/2019/digital.html#page=1 (V.S. Gillerman).

Professional Activities

Affiliate Faculty, Boise State University (V.S. Gillerman).

Affiliate Faculty, University of Idaho (V.S. Gillerman, R.S. Lewis, M.E. Ratchford).

Affiliate Faculty, Washington State University (R.S. Lewis).

Emeritus Faculty, University of Idaho (P.E. Isaacson).

Federal Aviation Administration Remote Pilot Certificate (Z.M. Lifton).

Fellow, Society of Economic Geologists (V.S. Gillerman).

Graduate Faculty Representative, Washington State University (R.S. Lewis).

Idaho Certified Water Rights Examiner (A. Clark, #156).

Idaho Registered Professional Geologist (A.L. Clark, D.M. Feeney, V.S. Gillerman, R.S. Lewis, Z.L. Lifton, M.E. Ratchford).

Leader, Lemhi Pass Field Tour, University of Missouri researchers, Salmon Area, July 2018 (V.S. Gillerman).

Member, American Association of Petroleum Geologists (M.D. Barton).

Member, American Exploration and Mining Association (V.S. Gillerman, R.S. Lewis).

Member, American Water Resources Association (A.L. Clark).

Member, Association of American State Geologists (M.E. Ratchford).

Member, Basin and Range Province Earthquake Working Group (Z.M. Lifton).

Member, Basin and Range Subcommittee, Western States Seismic Policy Council (Z.M. Lifton).

Member, Eastern Snake Plain Aquifer Model Technical Advisory Committee (A.L. Clark).

Member, Geological Society of America (C. Berti, V.S. Gillerman, R.S. Lewis, Z.M. Lifton).

Member, Geological Society of Nevada (V.S. Gillerman).

Member, Ground Water Monitoring Technical Advisory Committee (A.L. Clark).

Member, Idaho Association of Professional Geologists (M.D. Barton, A.L. Clark, R.S. Lewis, Z.M. Lifton, M.E. Ratchford).

Member, Idaho Lidar Consortium (Z.M. Lifton).

Member, Idaho Office of Emergency Management Seismic Technical Working Group (Z.M. Lifton).

Member, National Ground Water Association (A.L. Clark).

Member, Society for Mining, Metallurgy, and Exploration and Boise Section of Society for Mining, Metallurgy, and Exploration (V.S. Gillerman).

Member, Treasure Valley Modeling Technical Advisory Committee (A.L. Clark).

Member, Valley County Geothermal Working Group (A.L. Clark).

Member, Wood River Valley Modeling Technical Advisory Committee (A.L. Clark).

Member, Yellowstone Volcano Observatory (Z.M. Lifton).

Organizer, Belt Association Field Trip, Murray, September 2018 (R.S. Lewis).

Oregon Certified Water Rights Examiner (A. Clark).

Oregon Registered Professional Geologist (A.L. Clark).

Participant, American Exploration and Mining Association Annual Meeting, Spokane, Washington, December 2018 (V.S. Gillerman, R.S. Lewis).

Participant, Association of American State Geologists Annual Meeting, Fairmont Hot Springs, Montana, June 2019 (J.R. Brabb, P.E. Isaacson).

Participant, Association of American State Geologists Congressional Liaison Meeting, Washington D.C., February-March 2019. (M.E. Ratchford).

Participant, Belt Association Field Trip, Murray, September 2018 (C.A. Tate).

Participant, Belt Supergroup Field Trip, Teck Resources, Clark Fork, August 2018 (R.S. Lewis).

Participant, Big Lost River Basin Field Trip, Idaho Department of Water Resources and the U.S. Geological Survey, November 2018 (A.L. Clark, M.E. Ratchford).

Participant, Boise Section of Society for Mining, Metallurgy, and Exploration meetings, Boise, September 2018, January and March 2019 (V.S. Gillerman).

Participant, Digital Mapping Techniques Conference, Butte, Montana, May 2019 (D.M. Feeney, L.A. Tedrow).

Participant, Geological Society of America Cordilleran Section Field Trip, Flood basalts, rhyolites, and pre- to post-dating volcanism of the Columbia River Province in eastern Oregon, Portland, Oregon, May 2019. (D.M. Feeney).

Participant, Geology and Mineralization at Stibnite Mining District Field Trip, Stibnite, August 2018 (V.S. Gillerman, R.S. Lewis, M.E. Ratchford).

Participant, Idaho Environmental Forum, Boise, April 2019 (V.S. Gillerman).

Participant, Idaho Mining Conference, Boise, November 2018 (V.S. Gillerman, M.E. Ratchford).

Participant, Idaho Oil and Gas Commission Meeting, Boise, February, May 2019 (M.D. Barton).

Participant, Interstate Oil & Gas Compact Commission Annual Conference, Coeur d'Alene, September-October 2018 (M.D. Barton, M.E. Ratchford).

Participant, Oil and Gas Town Hall Meeting, Payette, March 2019 (M.D Barton).

Participant, Operation Shared Response, statewide earthquake exercise, March 2019 (Z.M. Lifton).

Participant, Palouse Basin Water Summit, Pullman, Washington, October 2018 (A.L. Clark).

Participant, Squaw Butte and the Mystery Boulder Field Field Trip, Idaho Museum of Mining and Geology, Squaw Butte, May 2019 (V.S. Gillerman).

Participant, U.S. Geological Survey National Geologic and Geophysical Data Preservation Program Focus Group Webinars, July, October, November, December 2018 (C.A. Tate).

Participant, U.S. Geological Survey Statemap Grant Review Panel, December 2018 (M.E. Ratchford).

Participant, Water Quality Workshop, Boise, January 2019 (A.L. Clark).

Representative, Boise State University (V.S. Gillerman).

Reviewer, Geophysical Research Letters Manuscript (Z.M. Lifton).

Reviewer, Geosphere Manuscript (Z.M. Lifton).

Reviewer, Montana Bureau of Mines and Geology Special Volume Manuscript (Z.M. Lifton).

Washington Certified Water Rights Examiner (A.L. Clark).

Washington Registered Geologist with Hydrogeologist Specialty (A.L. Clark).

Washington Registered Professional Geologist (Z.M. Lifton).

Graduate Thesis Committees

Andrew Canada, Ph.D. Geology, University of Idaho (P.E. Isaacson).

Clay McDonie, M.S. Geology, Washington State University (R.S. Lewis).

Niki Wintzer, Ph.D. Geology, Washington State University (R.S. Lewis).

Grants and Contracts

Data Preservation 11: R.S. Lewis (U.S. Geological Survey, July 2018-August July 2019, $24,127).

Development of a Statewide Landslide Inventory Database: Zach Lifton (Idaho Transportation Department, October 2018-October 2020, $90,114).

Geologic Mapping in the Preston, Weiser, Salmon, and Elk City Areas: R.S. Lewis and D.M. Feeney (U.S. Geological Survey Statemap Program, June 2018-May 2019, $159,330).

Geologic Mapping in the Preston, Weiser, Salmon, and Elk City Areas: R.S. Lewis and D.M. Feeney (U.S. Geological Survey Statemap Program, May 2019-May 2020, $164,417).

Geologic Mapping of the Swisher Mountain and De Lamar Quadrangles: V.S. Gillerman and D.M. Feeney, (Integra Resources Inc., May 2019-December 2020, $103,261).

Geologic Mapping in the Yellow Pine Quadrangle: R.S. Lewis (Wilmat Petroleum Company, May 2019-September 2010, $39,999).

Groundwater Budget for the Big Lost River Valley: A. Clark (Idaho Department of Water Resources, December 2018-October 2021, $125,000).

Idaho Department of Lands Abandoned Mine Lands Project, Task 4: R.S. Lewis (Idaho Department of Lands, February 2017-February 2019, $121,918).

Idaho Department of Lands Abandoned Mine Lands Project, Task 5: R.S. Lewis (Idaho Department of Lands, March 2019-November 2020, $141,677).

Leveraging Domain Repositories in Flyover Country, A Mobile App for Geoscience Outreach, Data Discovery and Visualization: R.S. Lewis and L.A. Tedrow (Arizona Geological Survey/National Science Foundation, February 2019-December 2019, $15,000).

LiDAR Training and Outreach: Zach Lifton (Federal Emergency Management Agency, September 2018-September 2019, $6,247).