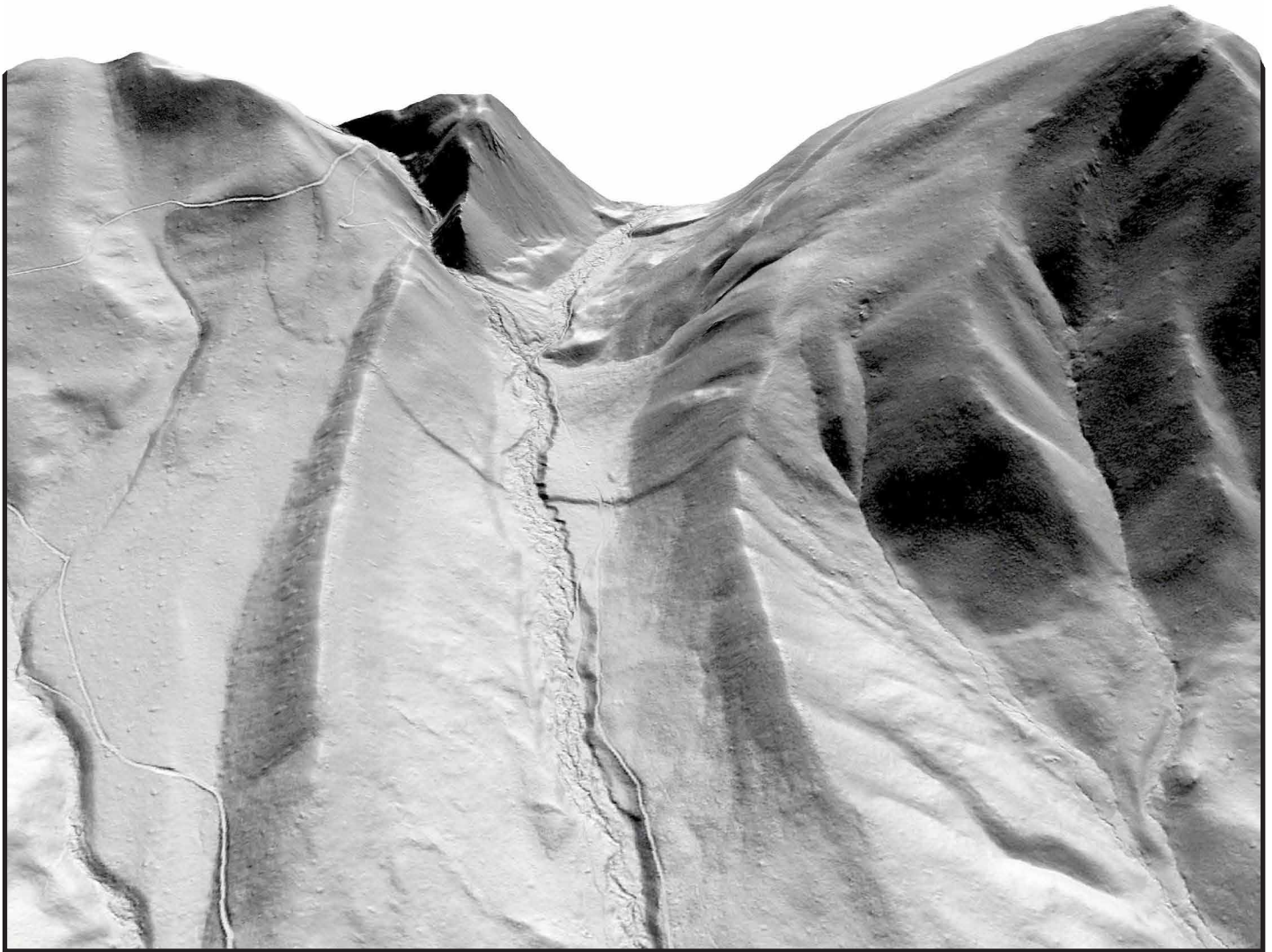


Annual Report
of the
Idaho Geological Survey



Fiscal Year 2017

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On the cover: Lidar image of the Boulder Creek area, Blaine County, Idaho showing prominent fault scarp cutting latest Quaternary glacial deposits of the Boulder Mountains. The image has been vertically exaggerated for artistic effect. Lidar was collected by the FEMA Idaho Risk MAP project in 2016.

TABLE OF CONTENTS

Introduction	1
Organization and Personnel	3
Organization Chart.	4
Directory	5
Idaho Geological Survey Advisory Board	6
Idaho Geological Mapping Advisory Committee	7
Fiscal Overview.	8
Sources of Funding.	9
Trends in Personnel Costs and Grants and Contracts Fiscal Years 2007-2017	9
Partnerships.	10
Association of American State Geologists.	10
Funding Partners	10
Collaborators	11
Research	12
Geological Mapping and Related Studies.	12
Hydrogeology	14
Geologic Hazards.	15
Mineral Resources and Mining.	18
Energy	23
Outreach	26
Publications	26
Website.	28
Social Media	29
Digital Mapping and GIS Laboratory	29
Databases and Archives.	29
Earth Science Education	30
Publications and Activities	31
Publications	31
Abstracts	34
Reports.	34
Presentations	35
Web Products	37
Operational Improvements.	37
Media Interviews	37
Professional Activities.	38
Graduate Thesis Committees	40
Grants and Contracts.	40

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. The IGS is a non-regulatory state agency that is administered as a Special Program of the University of Idaho. In addition to the main office on University of Idaho's Moscow campus, the Survey has southern branch offices in Boise located at the Idaho Water Center and at Boise State University. The agency is staffed by approximately 12 state-funded, full-time employees and 15 externally-funded, temporary and part-time employees.

The Survey's goal is to provide the state with timely and relevant geologic information and applied research, effective program accomplishments, and transparent access to the general public. 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 legislative mandate 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 of sponsored and cooperative research programs with a wide array of important partnerships at the local and federal level. The Survey's surface geologic mapping program is fundamental to solving and identifying a wide array of geologic problems and issues throughout the state. Both subsurface and surface geologic maps 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 software tools that permit 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, polymetallic and industrial minerals and aggregates, mining record compilations, and earth science educational outreach. As Idaho grows, demand is sharply increasing for geologic information related to population growth, 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 Professional Activities section of this report.



ORGANIZATION AND PERSONNEL

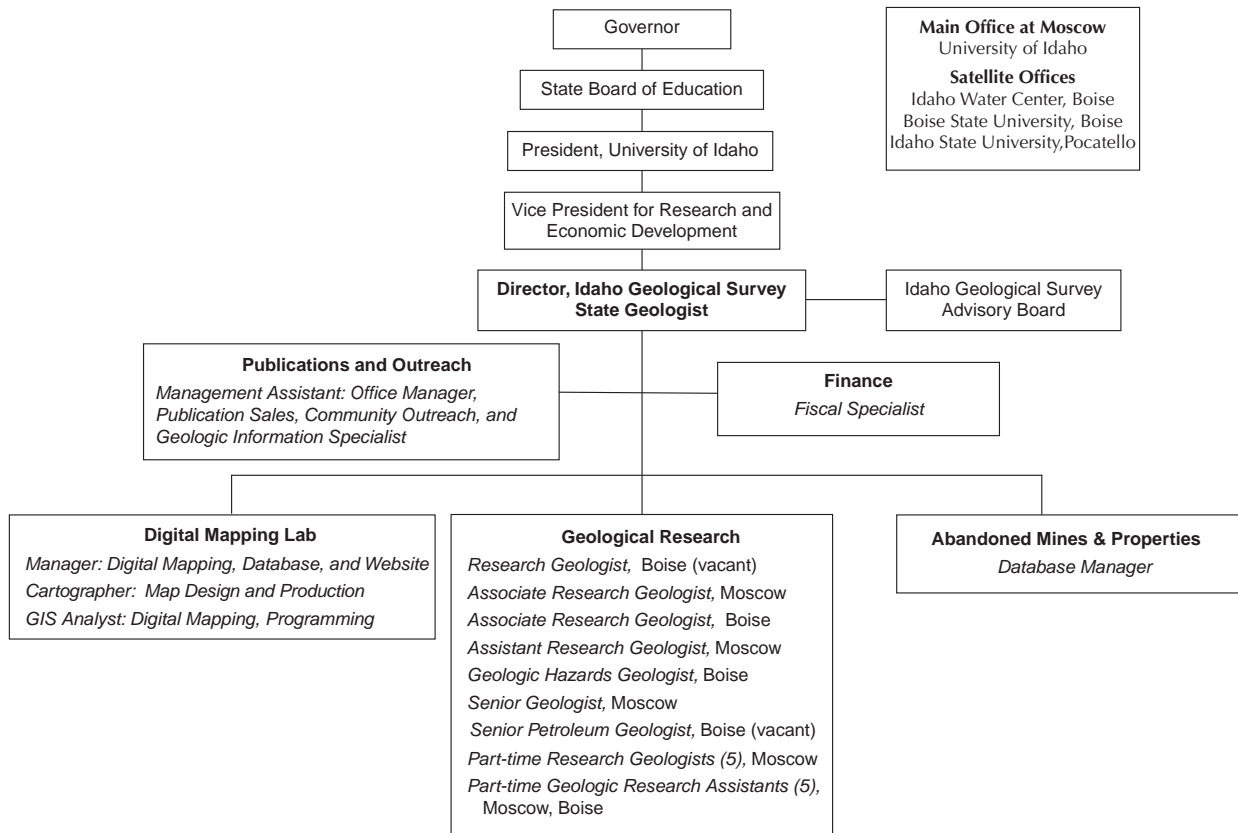
The IGS provided its geological services during fiscal year (FY) 2017 from the main office in Moscow and from their two satellite offices located in Boise and Pocatello. The IGS closed its Pocatello office effective December 31, 2016 concurrent with the retirement of IGS Hydrogeologist Dr. John Welhan. A national search is currently underway for his replacement, and that position will be stationed at the Boise office.

Workflow planning, supervision changes, and personnel reorganization were initiated in 2017 to prepare for two new IGS employees: Dr. Zach Lifton, Geologic Hazards Geologist stationed at the Boise office and Linda Tedrow, GIS Analyst stationed at the Moscow office. The vacancy from the Senior Petroleum Geologist position has been filled, and this employee will be stationed at the Boise office beginning the first quarter of 2018.

A pending legislative request was submitted during the spring of 2017 to add two new positions beginning in FY 2018: a Management Assistant for the Boise office and a Geologic Editor for the Moscow office. The organization chart below represents personnel, reporting, and office locations effective during FY 2017 which spans from July 1, 2016 to June 30, 2017.

Organization Chart

Idaho Geological Survey Fiscal Year 2017



Directory

Main Office at Moscow

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

Branch Office at Boise

Idaho Water Center, Suite 201
322 E. Front Street
Boise, ID 83702-7359
208-332-4420

Branch Office at Pocatello

Physical Science, Room 201B
Idaho State University
MS 8071
Pocatello, ID 83209-8071
208-282-4254

Administrative and Support Staff

Michael E. Ratchford Director, Moscow
John R. Brabb Fiscal Specialist, Moscow
Glenda K. Bull Administrative Specialist, Moscow
Kristen M. Pekas Management Assistant, Moscow

Research, Full-Time

Renee L. Breedlovestrout Senior Petroleum Geologist, Moscow
Dennis M. Feeney Senior Geologist, Moscow
Jane S. Freed Cartographer, Moscow
Virginia S. Gillerman Associate Research Geologist, Boise
Reed S. Lewis Associate Research Geologist, Moscow
Zachary M. Lifton Geologic Hazards Geologist, Boise
William M. Phillips Assistant Research Geologist, Moscow
Loudon R. Stanford Manager, Digital Mapping and GIS Lab, Moscow
Christopher A. Tate Database Manager Mines and Prospects, Moscow
Linda Tedrow GIS Analyst, Moscow
John A. Welhan Full Research Geologist, Pocatello

Research and Support, Part-Time

Megan M. Aunan Research Support
Russell F. Burmester Geologist
James C. Coogan Geologist
Hailey J. Couture Research Support
Eric J. Elliott Research Support
Dylan Porter Work Study
Korbon N. McCall Research Support
Kurt L. Othberg Geologist
Matthew A. Peterson Research Support
Keegan L. Schmidt Geologist
William Schuster Work Study
David E. Stewart Geologist
Eric D. Stewart Geologist
Ander J. Sundell Research Support
Kerrie N. Weppner Research Support
Adam Price Research Support

Idaho Geological Survey Advisory Board

Leslie Baker

Chair, Department of Geography and
Department of Geological Sciences,
University of Idaho

Susan Cleverly

Idaho Office of Emergency Management

Chris Dail

Exploration Manager,
Midas Gold Corporation

David Hawk

Representing Office of the Governor

Mike McCurry

Chair, Department of Geological Sciences,
Idaho State University

Dr. James “Jim” McNamara

Chair, Department of Geological Sciences,
Boise State University

Dan Moore

Professor, Department of Geology,
Brigham Young University - Idaho

Keith Nottingham

Geologist
Idaho Transportation Department;
American Geotechnics

Rich Reed

President,
Idaho Association of Professional Geologists

Tom Schultz

Director, Idaho Department of Lands

Ex Officio: Michael “Ed” Ratchford

Director and State Geologist,
Idaho Geological Survey

Idaho Geological Mapping Advisory Committee

Janet Hohle – Chair

Project Manager - Clearwater Focus Program
Idaho Governor's Office of Species Conservation

Jim Myers

Senior Exploration Geologist
Hecla Silver Valley, Inc.

James R. Bartolino

District Ground Water Specialist
U.S. Geological Survey, Idaho Water Science Center

Dennis Owsley

Technical Hydrogeologist
Idaho Department of Water Resources

Stephen Box

Research Geologist
U.S. Geological Survey Minerals Program

David Pearson

Assistant Professor, Department of Geosciences
Idaho State University

Dale Kerner

Mining Services Manager
Haley & Aldrich, Inc.

Karen Porter

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

Mark Kimsey

Intermountain Forestry Cooperative
Dept. of Forestry, Rangeland and Wildfire Sciences
College of Natural Resources, University of Idaho

Kenneth C. Reid

State Archaeologist and
Deputy State Historic Preservation Officer
Idaho State Historic Preservation Office

Sean Long

Assistant Professor, Earth Sciences
Washington State University

Diane Wheeler

Forest Geologist
Caribou-Targhee National Forests

Ryan McDaniel

Risk MAP Program Manager
Idaho Office of Emergency Management

FISCAL OVERVIEW

The Survey's state appropriated budget for FY 2017 was \$1,123,300, a \$299,100 increase from \$824,200 in FY 2016. This increase funded a new Geologic Hazards Geologist position and a new GIS Analyst position. In addition to the salary and benefits of these two positions, IGS received \$11,000 in ongoing travel and operations funding to support these two positions.

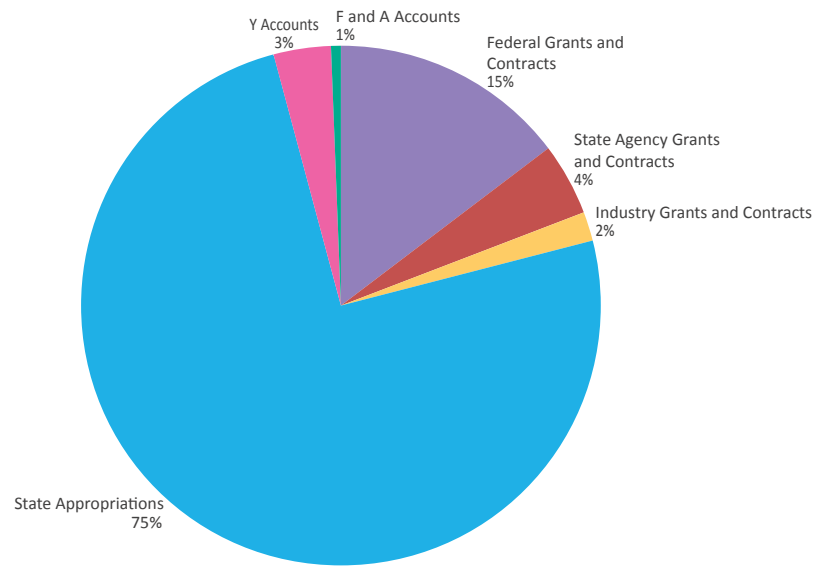
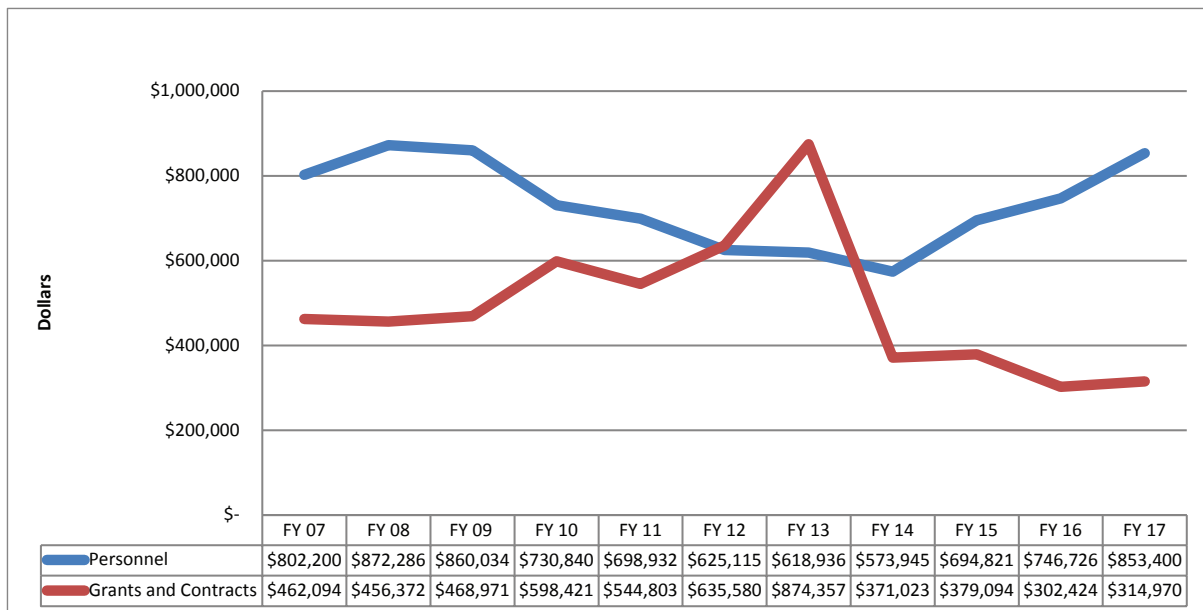
In FY 2017, IGS also received one-time funding for FY 2017's 27th pay period (an additional pay period that occurs every 11 years), geologic hazards aerial imagery, and funding to update computers, plotters, servers, as well as replacement of other ageing equipment.

The mandated reductions in the state budget in the past affected the agency's mission in research, public service, outreach, and education. It has been a slow process, but the additional line item funding and one-time funding in FY 2017 have revitalized the agency's mission.

Grants and contracts expenditures increased 4% from \$302,424 in FY 2016 to \$314,970 in FY 2017. In FY 2017, expenditures came from 12 projects, and in FY 2016, expenditures were spread over 20 projects.

Budget for Fiscal Year 2017					
Category	Beginning Balance	Income or Appropriation	Actual	Expense	Ending Balance
Personnel		\$ 1,035,400.00	\$ 853,400.00	\$ 853,400.00	\$ -
Operating Expense		\$ 33,000.00	\$ 134,696.14	\$ 134,696.14	\$ -
Capital Outlay		\$ 54,900.00	\$ 135,203.86	\$ 135,203.86	\$ -
Total Appropriations		\$ 1,123,300.00	\$ 1,123,300.00	\$ 1,123,300.00	\$ -
U/I Personnel Funds		-	-	-	-
Y Accounts	\$ 75,374.16	\$ 67,923.42		\$ 67,138.89	\$ 76,158.69
F and A Accounts	\$ 85,874.90	\$ 12,762.92		\$ 9,161.60	\$ 89,476.22
Grants and Contracts	\$ 388,675.19	\$ 284,733.47	\$ 314,969.81	\$ 314,969.81	(\$ 30,236.34)
TOTAL	\$ 549,924.25	\$ 1,488,719.81	\$ 1,438,269.81	\$ 1,514,570.30	\$ 135,398.57

Sources of Funding for FY 2017

Trends in Personnel Costs and Grants and Contracts
Fiscal Years 2007-2017

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 applied research and outreach.

Association of American State Geologists

IGS personnel attended the Annual Meeting of AASG last spring held in Branson, Missouri. The AASG is a strong advocate for the funding and reauthorization of the U.S. Geological Survey (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, the USGS, the National Geologic Map Database, and the annual Digital Mapping Techniques Workshops. 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

Idaho Bureau of Homeland Security and Boise State University (Seismic Study in Kootenai County)	Midas Gold Corporation (Stibnite and Burnt Log Projects)
Idaho Department of Lands (Abandoned Mine Lands Project)	U.S. Geological Survey (Reservoir Characterization and Petroleum Assessments; StateMap Cooperative Project; Data Preservation)
Idaho Transportation Department (Smiths Ferry Project)	

Collaborators

Alta Mesa Holdings, LLC	Lewis-Clark State College
American Exploration and Mining Association	Midas Gold Corporation
American Geological Institute	Missouri State University
American Water Resources Association, Idaho State Section	Montana Bureau of Mines and Geology
Americas Silver Corporation	National Association of Geoscience Teachers
Arizona Geological Survey	National Science Foundation, Geoscience Directorate
Association for Women Geoscientists	Nevada Bureau of Mines and Geology
Association of American State Geologists	New Jersey Mining Company
Bannock County Groundwater Overlay Advisory Committee	North Idaho College
Bannock County Planning and Zoning Department	Northwest Knowledge Network
Belt Association	Orma J. Smith Museum of Natural History
Boise State University	Palouse Prairie Charter School
Brigham Young University-Idaho	Portneuf Watershed Partnership
British Columbia Geological Survey	Professional Women in Earth Sciences Committee, American Association of Petroleum Geologists
Bryant University	Ralston Hydrologic Services, Inc.
California Geological Survey	Schlumberger Petroleum Services
Cedar Creek Resources	Shoshone-Bannock Tribal Water Resources Department
Center for Advanced Energy Studies	Society of Mining Engineers, Boise Section
China Geological Survey	Spokane Community College
China University of Geosciences	TerraGraphics
City of Pocatello Water Department, Planning Department, and Environmental Department	Tobacco Root Geological Society
College of Idaho	U.S. Bureau of Land Management
College of Western Idaho	U.S. Forest Service
Federal Emergency Management Agency	U.S. Geological Survey—Data Preservation
Franklin and Marshall College, Department of Earth and Environment Sciences	U.S. Geological Survey—Energy and Unconventional Fuels
Geological Society of America	U.S. Geological Survey—Idaho National Lab
Geomark Laboratories	U.S. Geological Survey—Minerals Program
Governor's Office, State of Idaho	U.S. Geological Survey—National Geologic Map Database
Hecla Mining Company	U.S. Geological Survey—StateMap
Ice Age Floods Institute	U.S. Geological Survey—US Topo
Idaho Department of Environmental Quality	U.S. Geological Survey—Water Resources Division
Idaho Department of Lands	U.S. Geothermal Inc. - Raft River Plant
Idaho Department of Water Resources	University of Alaska, Fairbanks
Idaho Environmental Forum	University of Idaho
Idaho Fish and Game Commission	University of Montana
Idaho Geospatial Council	University of Utah
Idaho Ground Water Monitoring Technical Committee	University of Wisconsin-Madison
Idaho Historical Society	Utah Energy and Geoscience Institute
Idaho Mining Association	Utah Geological Survey
Idaho Museum of Mining and Geology	Utah State University
Idaho National Laboratory	Washington Division of Geology and Earth Resources
Idaho Office of Emergency Management	Washington State University
Idaho Office of Energy Resources	Weatherford Laboratories
Idaho Oil and Gas Conservation Commission	Western States Seismic Policy Council
Idaho Science Teachers Association	Western State Colorado University
Idaho State University	Wichita State University
Idaho Transportation Department	Worldwide Geochemistry
Inside Idaho	Yellowstone Volcano Observatory
Intermountain Forestry Cooperative	

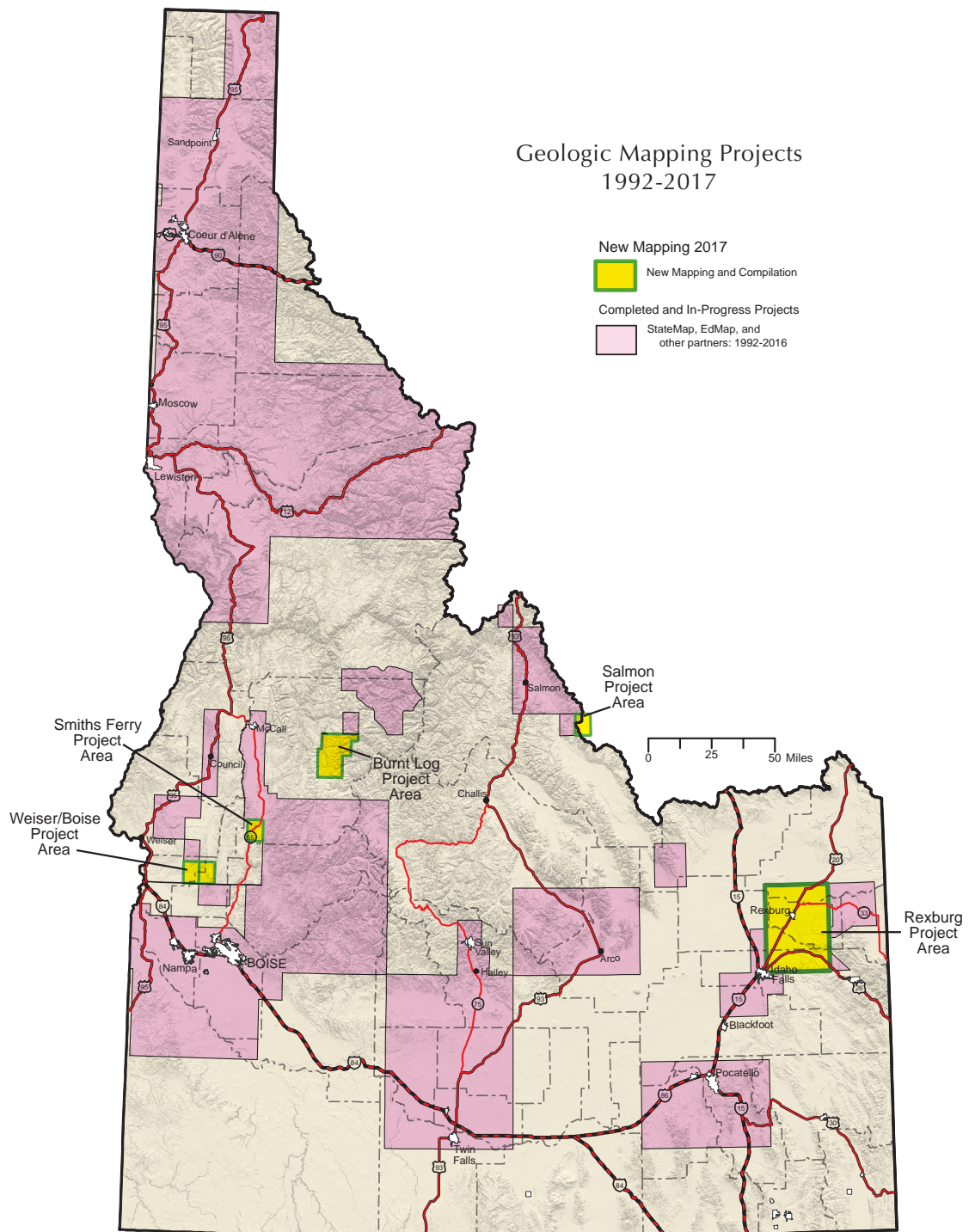
RESEARCH

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

Geological Mapping and Related Studies

Many IGS research projects consist of geologic mapping of 7.5' and 30' x 60' quadrangles. Before 1990, geologic mapping in Idaho was primarily conducted in localized rural areas to facilitate extraction of geologic resources. In the last two decades, the Survey has been mapping in targeted areas to address development impacts in urban settings, for recognition and assessment of new mineral, aggregate, geothermal, and oil and gas resources, and identification and monitoring of geologic hazards such as earthquake seismicity and landslides. The Idaho Geologic Mapping Advisory Committee (IGMAC) assists the Survey by assessing Idaho's mapping necessities and addressing long-term plans for geologic mapping. Idaho's geologic map products have been used to designate landslide hazards; to define mineralization potential; to delineate rock units that form boundaries of aquifers; to show geologic materials for engineering needs; to define groundwater resources; to aid in highway design and construction; and to define 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 \$3.9 million in federal funds and matched an equal amount of "in kind" salaried employee's participation to complete geologic mapping in Idaho. In FY 2017, new mapping was conducted in the Weiser-Boise, Rexburg, and Salmon project areas. During the year, Survey geologists mapped three 7.5' quadrangles (Hog Cove Butte, Squaw Butte, and Lemhi Pass) under the StateMap Program. In addition, the western half of the Rexburg 30' x 60' quadrangle was compiled. The results of ten years of mapping Belt Supergroup rocks in the Salmon area culminated in publication of the western part of the Salmon 30' x 60' quadrangle and the results were summarized in two papers published in the Geological Society of America "Special Paper" Series. The map and papers were co-authored by IGS and Montana Bureau of



Mines geologists who have been conducting collaborative mapping in this region under the StateMap Program. The Salmon map also shows details of Tertiary and Quaternary depositional units important to the region's water resources that have been underemphasized in previous regional geologic mapping projects. A 50-page, well-illustrated booklet accompanies the Salmon map, providing additional background information on the geologic history of the region.

Mapping and delineation of potential landslide hazards was also conducted along the proposed Burntlog Road Access Route near Stibnite with funding provided by Midas Gold Corporation. A summary of potential aggregate sources along the route was also completed. Work for the Idaho Transportation Department (ITD) in the Smiths Ferry quadrangle south of Cascade was completed in FY 2017, and the quadrangle map was delivered to ITD. This mapping was in support of geologic work by industry and ITD geologists for a Highway 55 road-widening project northeast of Smiths Ferry.

Hydrogeology

Hydrogeologic work by the IGS during FY 2017 involved elements of outreach, service, and education, with an emphasis on applied research focused on aquifer water-balance analysis and geochemical indicators of groundwater flow paths and nonpoint-source impacts of groundwater contamination. Outreach and education activities involved an ongoing applied-research project with the Shoshone-Bannock Tribes to predict and manage water supply shortages, and collaboration with the Tribes and Idaho State University (ISU) has continued to create a science, technology, engineering, and mathematics (STEM) education-development program for Native American students. Other areas of effort included providing technical advice to Idaho Department of Environmental Quality's (IDEQ) groundwater monitoring program, interaction with local planners and private well owners, and wrapping up the IGS Pocatello office's graduate student research and mentoring work at ISU and University of Idaho prior to John Welhan's retirement at the end of 2016.

Research activity in FY 2016 included completion of an eight-year water balance analysis of the south Ross Fork Basin aquifer on the Fort Hall Reservation, results of which will be published through IGS at the request of the Tribes' Water Resources Department and used to help manage future water supply shortages that may develop in drought years. The Survey's long-running hydrologic program investigating the lower Portneuf River Valley (LPRV) groundwater system continued as part of the Idaho EPSCoR MILES (Managing Idaho's Landscapes

for Ecosystem Services) project, which previously identified an unrecognized source of recharge to the LPRV aquifer from thermal groundwater that originates as upflow along the valley's Basin and Range faults.

The IGS also collaborated with ISU faculty and students on a comprehensive groundwater sampling program in the LPRV that quantified spatial and temporal trends of septic effluent impacts on municipal and rural residential drinking water, including the identification of pharmaceutical and personal care products in septic impacted groundwater, which definitively marked the accompanying nitrate contamination as septic-sourced, rather than of an agricultural origin. The IGS also worked with the City of Pocatello and supervised two MILES-funded ISU student interns who compiled GIS data documenting 45-year septic-based development trends within and around the City of Pocatello's urban boundary.

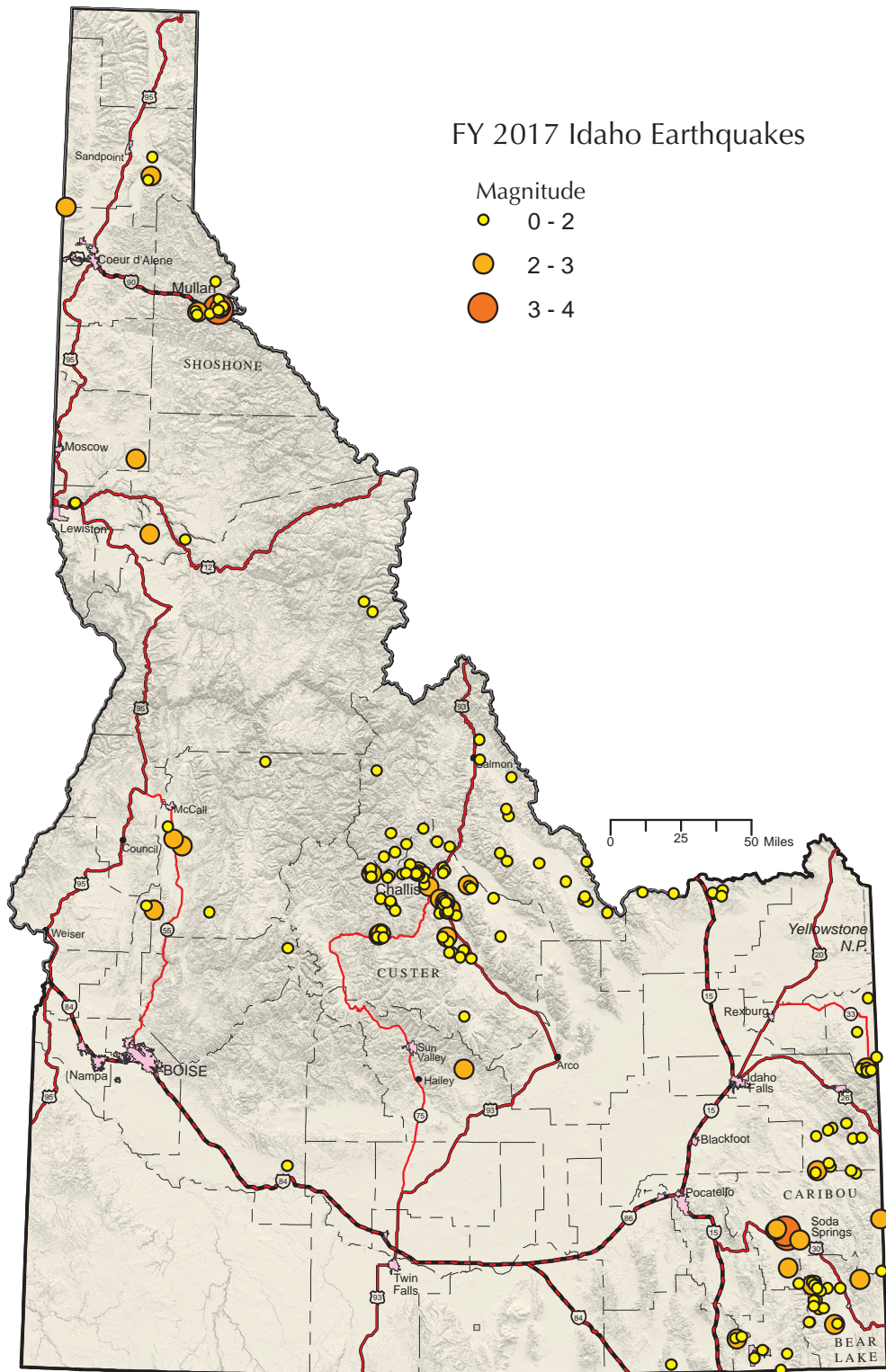
Geologic Hazards

Overview

Idaho is prone to earthquakes, volcanic eruptions, landslides, and alluvial fan flooding. The Survey assists with mitigation of these hazards in several ways:

- Geological mapping through the USGS StateMap program provides baseline information on the location, size, and frequency of these hazards. This information may be incorporated into planning documents and also serves as the basis for more detailed studies.
- Expert opinion and advice are provided to state and federal agencies involved with Idaho hazard mitigation. This includes the Idaho Office of Emergency Management (IOEM), and the U.S. Federal Emergency Management Agency (FEMA).
- Public education and outreach through publications, press releases, media interviews, social media, and occasional public lectures.
- Participation 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.

In FY 2017, the Survey participated in FEMA's Risk MAP (Mapping, Assessment, and Planning) program. A key part of Risk MAP is updating flood insurance rate maps with high resolution lidar surveys. Lidar has great potential to identify hazards from alluvial fan flooding, debris flows, landslides, and active faults. IGS participated in public Risk MAP presentations in Clearwater, Nez



Earthquakes during FY 2017 in Idaho. Source: USGS-ANSS Comprehensive Earthquake Catalog for 07-01-2016 to 06-30-2017.

Perce, and Valley counties, and lidar-based assessment of landslide hazards in the Big Wood River drainage basin of Blaine, Lincoln, and Gooding counties.

Also new in FY 2017, the Survey received funding from the Idaho legislature for a new Geologic Hazards Geologist position, to be based at the IGS office in Boise. This position was filled by Dr. Zach Lifton in June 2017.

Earthquakes

Survey staff are informed about Idaho and important regional earthquakes through seismic monitoring performed by the USGS, Montana Bureau of Mines and Geology, the University of Utah, the Idaho National Laboratory, and the Pacific Northwest Seismic Network. When an earthquake occurs, location, magnitude, and shaking intensity data are posted within minutes to the internet by the USGS. IGS staff members receive automated emails and cell phone texts for Idaho-area earthquakes and also check the USGS website for major regional activity on a regular basis.

In FY 2017, earthquakes with magnitudes >3.0 occurred near Soda Springs in Caribou County and near Mullan in Shoshone County. Clusters of smaller earthquakes also occurred in Custer and Bear Lake counties. No damage from any of these earthquakes was reported.

Volcanic Eruptions

The Survey collaborates with monitoring of regional volcanic activity as a member of the Yellowstone Volcano Observatory Consortium (YVO). YVO members consist of the USGS, Yellowstone National Park, University of Utah, and the geological surveys of Idaho, Wyoming, and Montana. In the event of volcanic ash eruptions from Cascade volcanoes, the Survey will collaborate with the USGS Cascade Volcano Observatory.

In FY 2017, no volcanic eruptions occurred in Idaho. However, seismicity possibly related to Yellowstone volcanic activity commenced in June 2017 with a magnitude 4.5 earthquake located about 8 miles north-northeast of the town of West Yellowstone, Montana.

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.

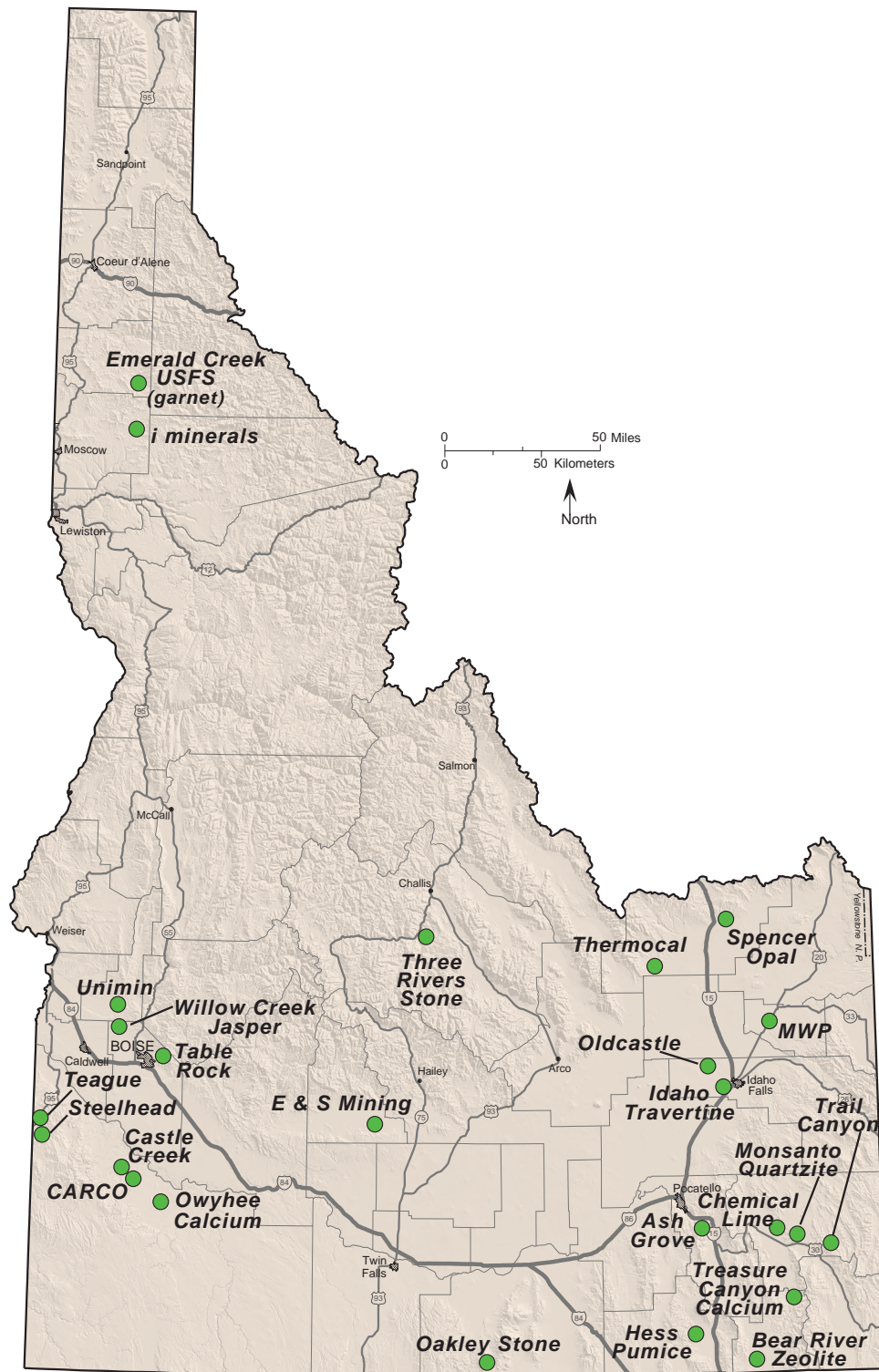
In FY 2017, Idaho experienced severe winter storms. Roads and bridges in many areas of the state were damaged by landslides, alluvial fan debris flows, and sheet flooding. Several train derailments related to landslides or rock falls were reported. Landslide damage to several homes in the Boise foothills continued from FY 2016.

Mineral Resources and Mining

Active Mining and Exploration

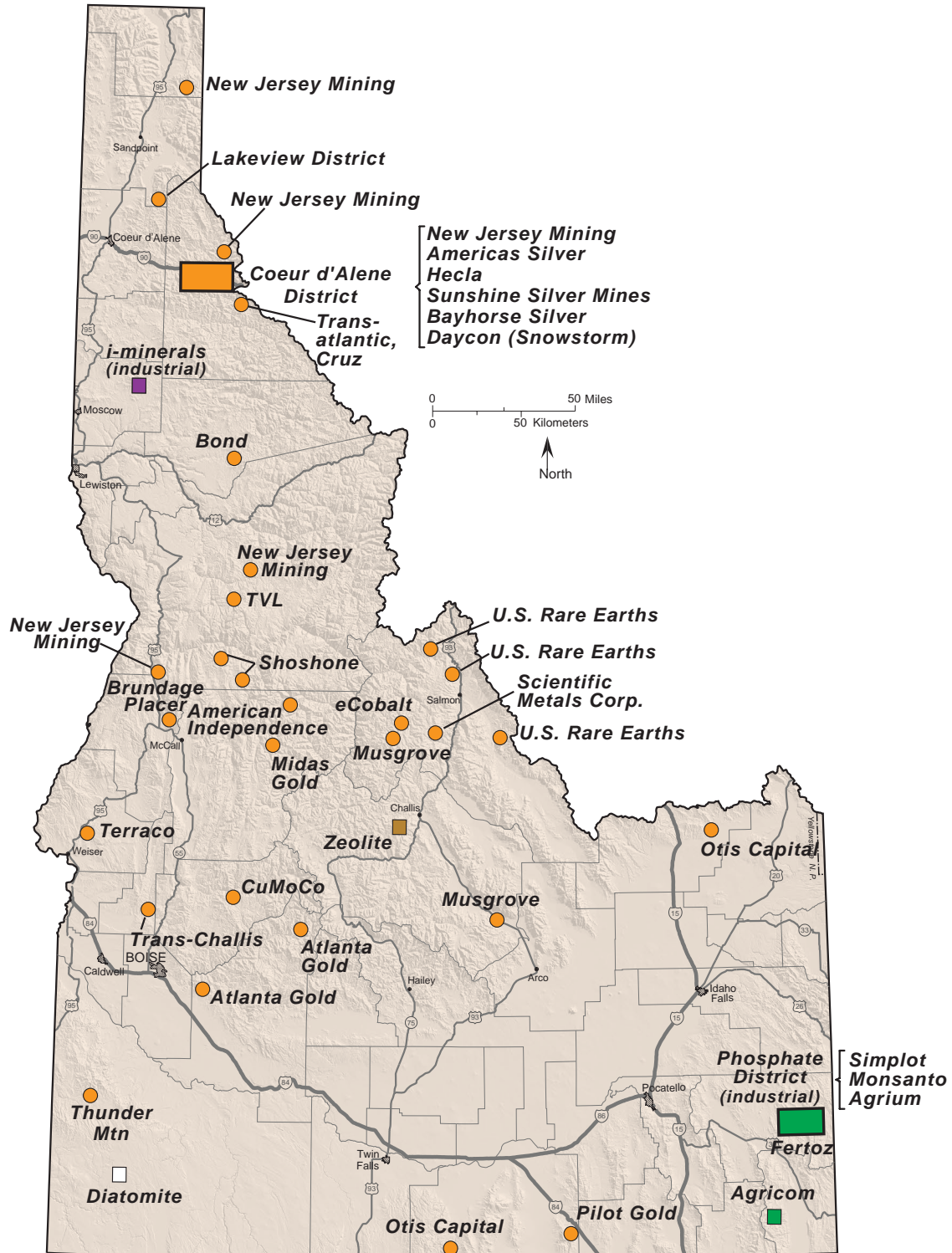
The IGS continued its long history and statutory responsibility of providing an annual update on Idaho's mining industry. IGS is the lead state agency for mineral research and routinely compiles and disseminates information on the state's mineral resources. One facet of the program is collaboration with the USGS in production of the Idaho chapter of the Minerals Yearbook, a global compilation of developments and statistics on mining and minerals information. During FY 2017, the annual summary for calendar year 2016 minerals activity was presented at the American Exploration and Mining Association (AEMA) annual convention in December. In recent years, mineral exploration and development activity has been hampered by low metal prices and a major mine closure, but by the second half of 2016 metal prices have risen, particularly for silver and gold, and the general economic picture looks more favorable thus providing impetus and investment dollars for reevaluation of several mining districts in 2017. The USGS estimate of Idaho's value of nonfuel mineral production in calendar year 2016 was \$654 million, ranking 33rd among the states. Principal Idaho commodities by value were phosphate rock, construction sand and gravel, silver, lead, and crushed stone. During FY 2017, three large open pit phosphate mines operated in Caribou County, and for most of the time two underground silver mines operated in Shoshone County. However, union workers at Hecla's Lucky Friday mine went on strike March 13, 2017, and mine production has ceased.

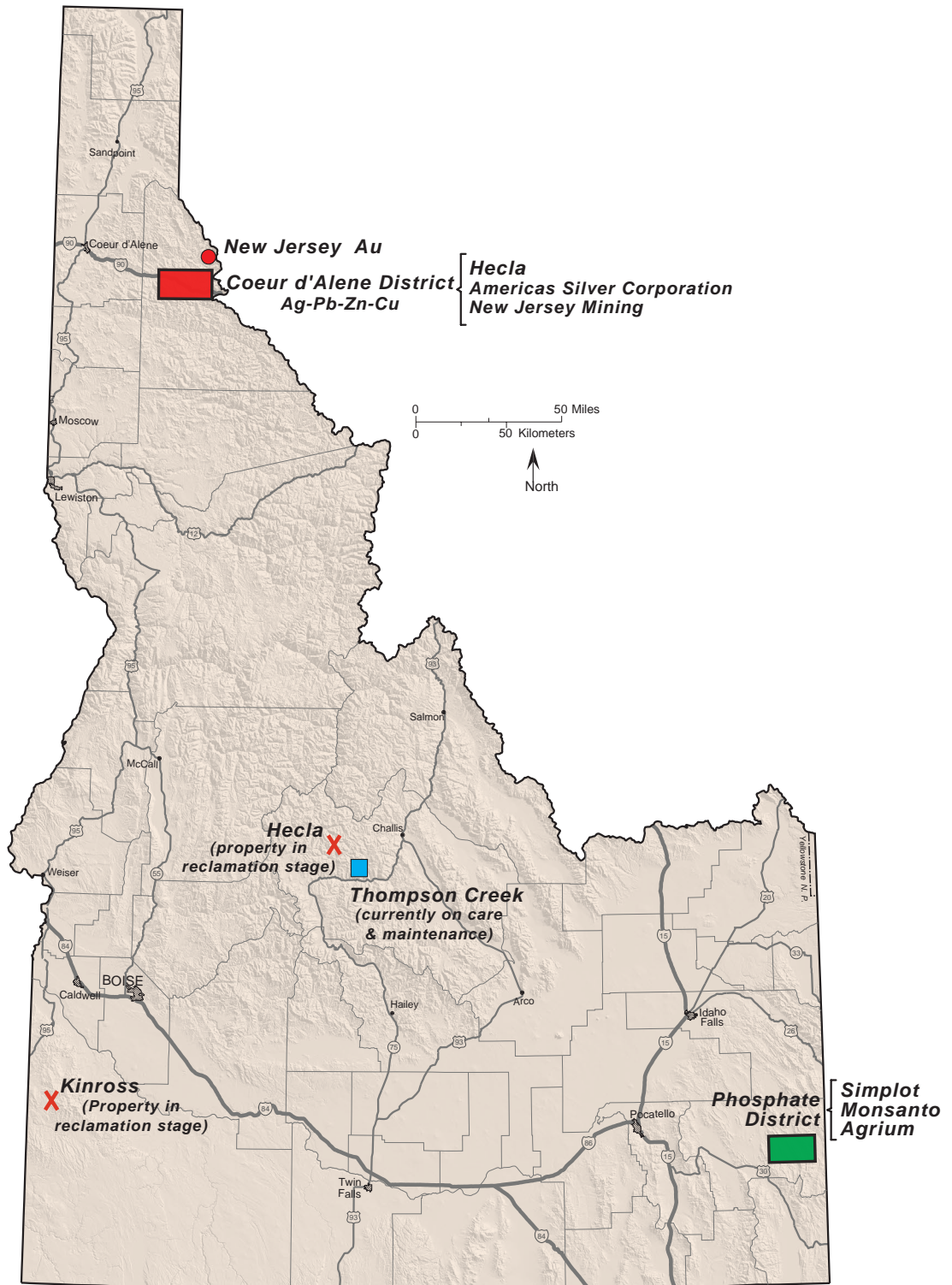
On the exploration front, Midas Gold Corporation submitted a mine and restoration plan to the U.S. Forest Service in September 2016 initiating the NEPA process. Midas Gold seeks to develop a gold-antimony mine in the historic Stibnite district in Valley County. The proposal plans for remediation of the open pit and restoring the river for fish migration at the end of the mining cycle. Otis Gold reported good results on a new ore zone at the Kilgore project in eastern Idaho. By the start of 2017, rising cobalt prices, due partly to their use in rechargeable batteries, prompted new interest in the Idaho Cobalt Belt by eCobalt (formerly Formation Capital) and newcomer, US Cobalt, Inc., who



INDUSTRIAL MINERALS AND AGGREGATES

Calendar year 2016





ACTIVE MINES
Calendar year 2016

acquired and was exploring the Iron Creek property. Another newcomer, Phoenix Global Mining, was drilling the Empire mine property at Mackay in 2017.

Minerals-Related Research

IGS mineral research is focused on a collaborative project supported by Midas Gold at the Stibnite or Yellow Pine mining district in Valley County. Historic production has been associated with antimony, tungsten, gold, and mercury resources. The IGS-Midas project started in 2012 includes two subprojects: a district mapping task and a geochronology, ore paragenesis, and alteration study of the deposits. The final 1:24,000 scale geologic map of the Stibnite 7.5' quadrangle was published as IGS Geologic Map 51 in December 2016. It includes a summary map of the region showing the extensional graben that cuts the Thunder Mountain volcanics east of Stibnite. Work continues on assimilating and interpreting the petrographic, age dating, isotopic, and microprobe studies of the hydrothermally altered host rocks and ores. Results of the project indicate there were at least two major pulses of gold mineralization during the Paleocene and Eocene plus younger antimony-tungsten mineralization along structures. Microprobe work reveals zoning of trace elements (including gold) in pyrite with multistage growth patterns. Age dating of scheelite, a calcium tungstate mineral, has been one of the new techniques evaluated during the project.

Two invited talks on Stibnite and Idaho ore deposits were presented in China by Dr. Virginia Gillerman of the IGS as part of an informal exchange facilitated by the USGS in December. The Stibnite district shares similarities to certain ore deposits in China.

The IGS played a major role in providing input and assessments for mineral resources during FY 2016 through FY 2017. IGS provided expert advice, testimony and assessment of the state's rich mineral assets and how these resources could be impacted if Bureau of Land Management's (BLM) proposal were successful to withdraw 3.8 million acres from mineral entry in the Sagebrush Focal Areas of Idaho. The IGS cooperated with State officials, department heads of state agencies, and the Governor's office to write an Idaho proposal for mineral access protection and then provided comments in January pertaining to the BLM's Draft Environmental Impact Statement.

Energy

Geothermal

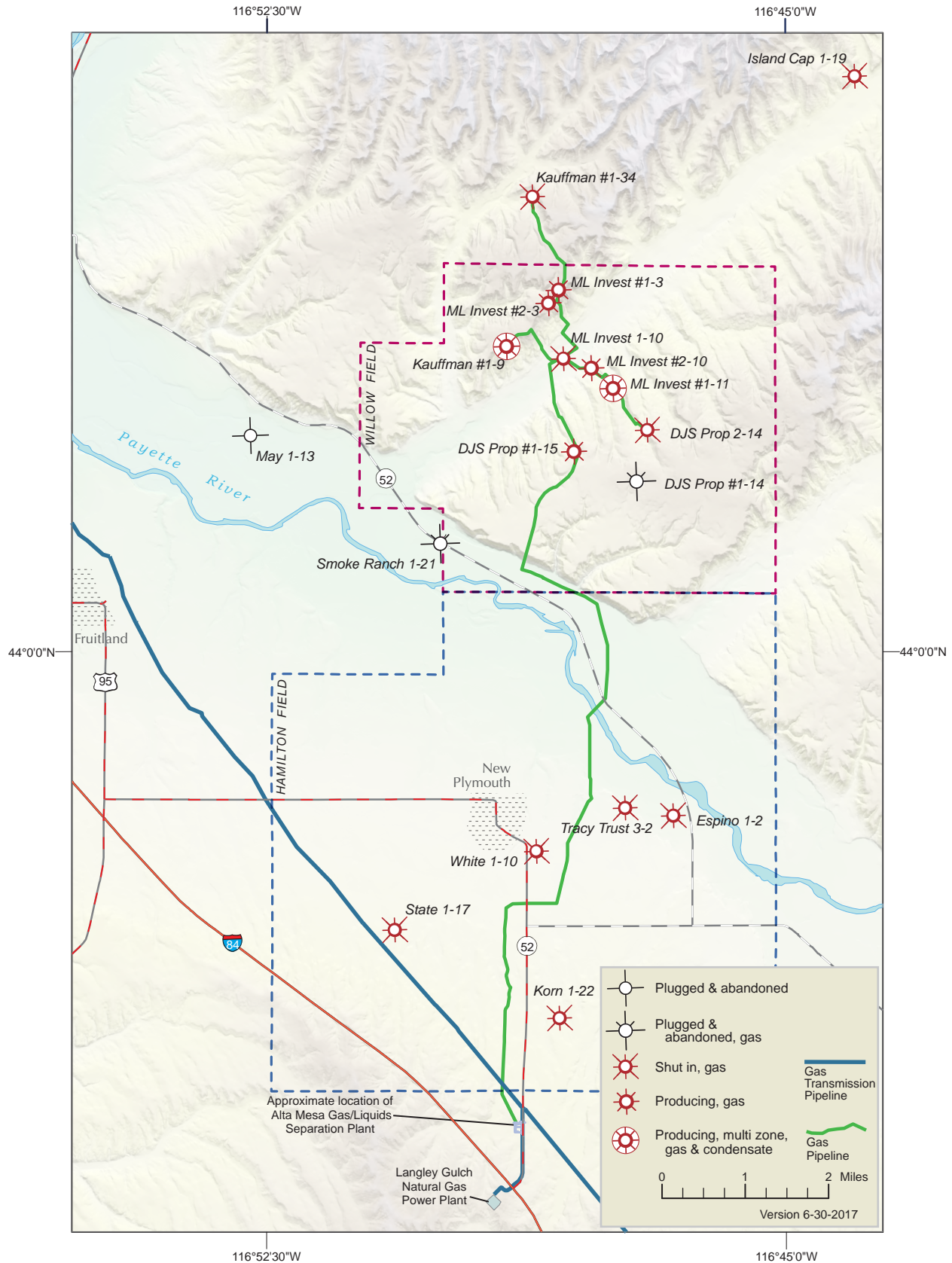
The IGS continued its research on geothermal energy during FY 2017 focusing on the analysis and reporting of data compiled during the Department of Energy-funded National Geothermal Data System (NGDS) project (2010-2014) in which a new high-temperature geothermal resource was identified at 2 to 5 km depths in the Idaho thrust belt (ITB).

The comprehensive technical report for the NGDS project was completed in FY 2016 and is currently in the final stage of internal editorial review. Its format represents a departure from the Survey's traditional reports in that it will be released as a stand-alone document plus a separate digital data appendix that is used to characterize and quantify the nature of geothermal energy resources in the ITB as well as its economic potential. The report includes a comprehensive integration and synthesis of all data compiled during the NGDS project, recommendations for additional research and development, and a testable conceptual model of the hydrothermal system based on what is known of its volcanic heat source, structural controls and reservoir architecture, and its hydrogeologic heat flow characteristics. The report, to be published under the Survey's Technical Report Series, has gone through detailed peer review by Idaho geothermal scientists. The digital data appendix was conceived as a means to facilitate the dissemination of findings and to spur their utilization for future research and the economic development of this resource.

Based on available oil and gas exploration well data, the ITB geothermal system has a median estimated power-generation potential of over a gigawatt of electricity (assuming a 30-year power plant life cycle), whether via conventional flashed-steam or binary-cycle power-conversion technology.

Oil and Gas

Oil and gas exploration and development efforts have been focused on the western Snake River Plain, specifically areas proximal to the community of New Plymouth, areas to the north toward Midvale, and to the west toward Vale, Oregon. Drilling from 2010 to the present has resulted in over 18 new well completions, six of which are currently in production near New Plymouth (see southwest Idaho natural gas figure). The IGS is monitoring activity in the field including the exploration and drilling of new wells, emplacement of pipeline and gas plant infrastructure, acquisition of 3-D seismic surveys, and mineral lease acquisition. Collaboration and research agreements between public and private entities (Idaho Department of Lands and Alta Mesa Holdings) have permitted the Survey to acquire subsurface data, sample producing wells, and begin the



Southwestern Idaho Natural Gas Play (small-scale version of DWM-172 as of June 2017)

process of petroleum system modeling and assessment for the region. The IGS was awarded a five-year research grant from the USGS to conduct reservoir characterization and petroleum assessment of this newly discovered resource in the southwestern part of the state. Furthermore, over \$12 million in petroleum modeling software has been donated to the Survey and the University of Idaho from industry partnerships including Schlumberger's Petrel Exploration & Production Platform, IHS's Petra, and SMT's Kingdom Geological Interpretation Software. A digital map covering this area, [Southwestern Idaho Natural Gas Play \(Digital Web Map 172\)](#), is available for download on the Survey's website.

Drill core and well cuttings analysis, subsurface mapping, well log correlations, microfossil designations, source rock evaluation, chemical and isotopic analysis of natural gas and liquid condensates, and petroleum system modeling are included within the current scope of research for the petroleum resources in southwestern Idaho. In conjunction with this scope of work, new geologic surface mapping projects are underway in the Weiser-Payette area with the objective of tying the surface geological units to reservoir rocks in the producing basin at depth.

The IGS has also identified the areas of southcentral 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. Collaboration and research agreements between IGS and Cedar Creek Resources are now in place to gain further subsurface information to study the potential petroleum system in south-central Idaho. As new drilling and completion technologies have advanced in recent years, both of these areas should be reevaluated for oil and gas resources, particularly from unconventional reservoirs.

The IGS maintains files on over two hundred historic oil and gas exploration wells in the state. These files include well reports and downhole logs provided by companies to the Idaho Oil and Gas Commission from 1903-1988. The files were transferred to the IGS in 2009 from the Idaho Department of Lands and consist of drilling correspondences, permits and applications, industry reports, maps, and geophysical logs. Many are unique historic documents and in fragile condition. Recent geothermal and oil and gas exploration activities in Idaho have greatly increased the number of requests for these data. The Survey has now scanned all of the reports and logs and made them available for download from the IGS website, and 25 of the historic logs have been digitized and incorporated into the Weiser-Payette area subsurface petroleum system model. As other historic and contemporary reports become available, IGS will continue to enhance and expand the oil and gas archive geodatabase.

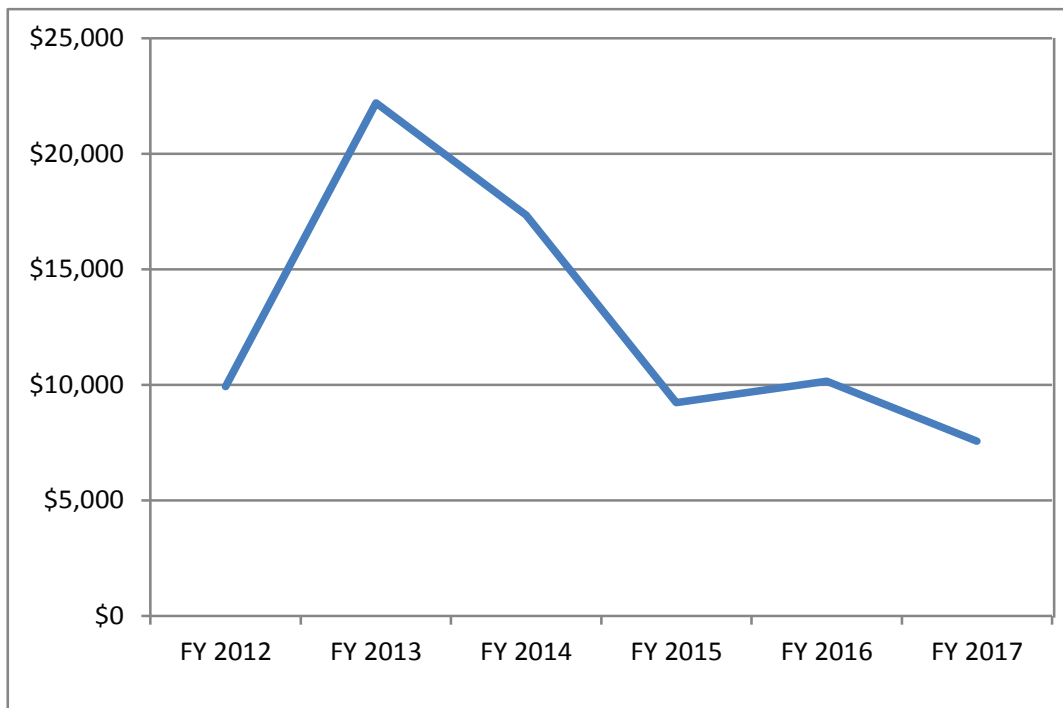
OUTREACH

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.

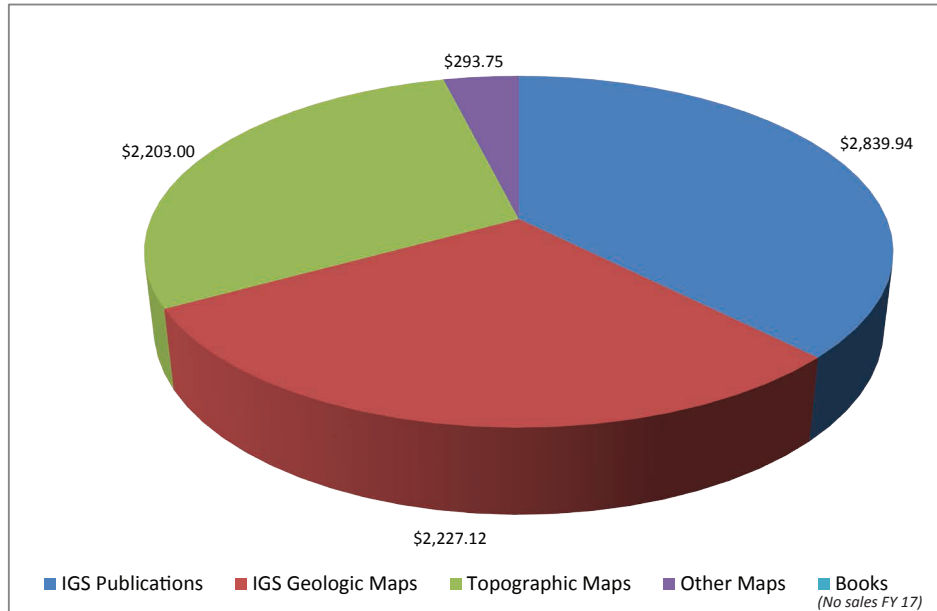
Publications

In FY 2017, IGS publications (IGS Bulletins, Technical Reports, Pamphlets, and others) outsold other types of publications, accounting for 38% of total sales. Since its release in 2012, the Geologic Map of Idaho has continued to be the best seller of IGS-produced publications. Nearly all publications are available for free download on the IGS website.

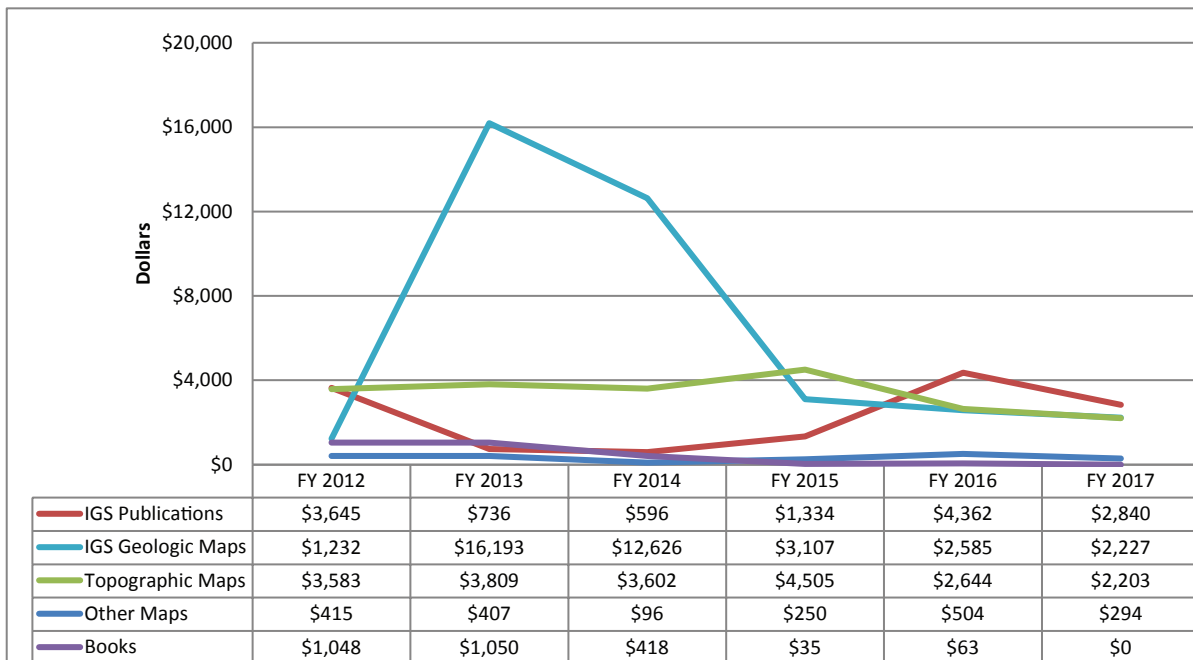
Total Publication Sales
Fiscal Years 2012-2017



Publication Sales in Dollars for FY 2017



Overview: All Sales Categories Fiscal Years 2012-2017

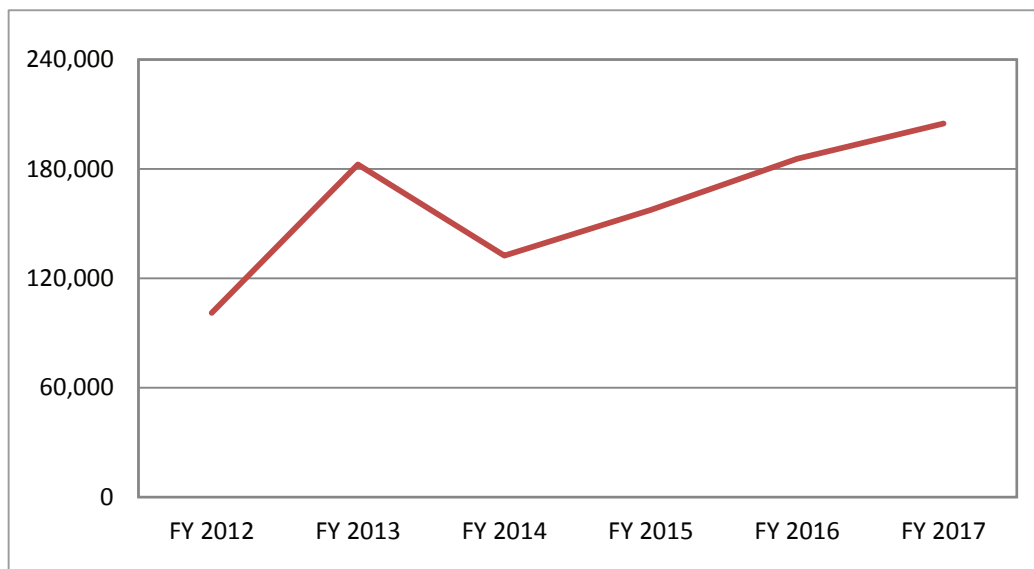


Website

www.idahogeology.org

The IGS website provides customers easy access to agency publications and data. Nearly all of IGS publications (over 980) are available free for download. Finding information on the website has been simplified through search engines, including web map applications. More than 13,000 visitors used these web map applications to explore Idaho. Thousands of additional mine documents were also added to the download capabilities of the Mines web application. In FY 2017, 453,562 visits were logged on the website, and users downloaded 204,770 products. Six new IGS publications were posted on the website this year.

Product Downloads



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, post general geoscience information, and post job announcements. In FY 2017, IGS Facebook posts reached over 400 Facebook users. In FY 2017, IGS tweeted 38 times and currently has 815 Twitter followers.

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. The lab continues to compile geology from around the state in geologic map databases, in addition to producing geologic map products. Nine 7.5' geologic maps were digitized (as stand-alone or compilation efforts) and four geologic maps were published this year. All are available as printed products or can be viewed free on the IGS website. As of this year, the lab is capturing new geologic map data in the NCGMP09 format using ArcGIS. For many years, the Survey captured geologic map data in IGS format in AutoCAD. These data are also being converted to the NCGMP09 format and made available for download on the IGS website.

Databases and Archives

Databases continue to be an important way of managing and distributing information to IGS customers via the agency website. Database updates of active faults, mines and prospects, oil and gas wells, and survey publications are an ongoing effort.

- New gas wells in the western Snake River Plain, Payette County, were added to an updated design of the IGS Oil and Gas database. These design changes for both historic and active wells increase the ability to use oil and gas data to answer questions and solve subsurface geology issues across the state. The IGS publication 'Southwestern Idaho Natural Gas Play' reflects these updates and can be found on the agency website.

- The Mines and Prospects database underwent operational improvements, as well as continued efforts to expand content and improve accuracy. The main access to these data is via the Mines web application. For this year, new functionalities have been added to the database. Newly entered or updated source references may now be exported as text files in several formats. The Survey annual mining reviews and presentations are now incorporated in the database. Nearly 10,000 mine maps, unpublished reports, and other mining-related documents are now available for download through the Mines web application. Approximately 10,300 mine documents were downloaded by IGS customers this year.
- The IGS aggregate material database was maintained and updated as part of an IGS Web Map application.
- The Survey continued this year to release GIS geologic map compilation data in NCGMP09, a national voluntary standard for geologic map data in ESRI geodatabase format. The Bonners, Sandpoint, Headquarters, Salmon, Grangeville, and Fairfield 30 x 60 minute geologic map compilation data sets are now available for download. The Long Valley surficial geologic compilation and the Grand View-Bruneau geologic compilations are also available for download. These GIS data sets were compiled from 1:24,000 geologic mapping data.

Earth Science Education

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 member societies, to help build a better understanding and appreciation of the earth sciences by delivering specially designed resources and activities to educators. The IGS received fifty 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 southwestern Idaho. The IGS also participated in the “Geologic Map Day” event during Earth Science Week by highlighting the recently published Western Part of the Salmon 30’ x 60’ quadrangle on the IGS website and social media. The IGS has also given presentations and demonstrations to elementary students in the local area per teacher request. Outreach is increasing with a growing email and mailing list to provide earth science information to earth science and physical science teachers.

PUBLICATIONS AND ACTIVITIES

Publications

- Construction and Preservation of Batholiths in the Northern U.S. Cordillera*, by Richard M. Gaschnig, Jeffrey D. Vervoort, Basil Tikoff, and Reed S. Lewis: *Lithosphere*, Vol. 9, No. 2, P. 315-324, 2017.
- Database of the Mines and Prospects of Idaho (version 1.2016.1)*, by Christopher A. Tate, Victoria E. Mitchell, Ruth E. Vance, Earl H. Bennett, B. Benjamin E. Studer, Loudon R. Stanford, and Jesse A. Hinshaw: Idaho Geological Survey, Digital Database 1, 2016.
- Field Guide to the Rexburg Bench, Idaho*, by Glenn F. Embree, Daniel K. Moore, and William M. Phillips: *Northwest Geology*, Vol. 45, P. 107-124, 2016.
- Geologic Field Guide to the Heise Volcanic Field, Eastern Snake River Plain, Idaho*, by William N. Phillips, Daniel K. Moore, and Glenn F. Embree: *Northwest Geology*, Vol. 45, P. 155-178, 2016.
- Geologic history of the Blackbird Co-Cu district in the Lemhi subbasin of the Belt-Purcell Basin*, by Arthur A. Bookstrom, Stephen E. Box, Pamela M. Cossette, Thomas P. Frost, Virginia S. Gillerman, George R. King, and N. Alex Zirakparvar, in MacLean, J.S. and Sears, J.W., eds.: *Belt Basin: Window to Mesoproterozoic Earth*: Geological Society of America, Special Paper 522, P. 185-219, 2016.
- Geologic Map of the Poison Creek Thrust Fault and Vicinity near Poison Peak and Twin Peaks, Lemhi County, Idaho*, by Connor M. Hansen and David M. Pearson: Idaho Geological Survey, Technical Report 16-1, scale 1:24,000, 2016.
- Geologic Map of the Riggins Hot Springs Quadrangle and Adjacent Areas, Idaho County, Idaho*, by David E. Blake, Michelle L. Bruce, and Dawn N. Reed: Idaho Geological Survey, Geologic Map 53, scale 1:24,000, 2016.
- Geologic Map of the Stibnite Quadrangle, Valley County, Idaho*, by David E. Stewart, Eric D. Stewart, Reed S. Lewis, Kerrie N. Weppner, and Vincent H. Isakson: Idaho Geological Survey, Geologic Map 51, scale 1:24,000, 2016.

Geologic Map of the Western Part of the Salmon 30 X 60 Minute Quadrangle, Idaho and Montana, by Russell F. Burmester, Reed S. Lewis, Kurt L. Othberg, Loudon R. Stanford, Jeffrey D. Lonn, and Mark D. McFaddan: Idaho Geological Survey, Geologic Map 52, scale 1:75,000, 2016.

Giant folds and complex faults in Mesoproterozoic Lemhi strata of the Belt Supergroup, northern Beaverhead Mountains, Montana and Idaho, by Jeffrey D. Lonn, Russell F. Burmester, Reed S. Lewis, and Mark D. McFaddan, in John S. MacLean and James W. Sears, *Belt Basin: Window to Mesoproterozoic Earth*: Geological Society of America, Special Paper 522, P. 139-162, 2016.

GIS Geodatabase for the Geologic Map of the East Half of the Bonners Ferry 30 x 60 Minute Quadrangle, Idaho and Montana, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, and Collette Gantenbein: Idaho Geological Survey, Digital Web Map (GIS) 17, 2017.

GIS Geodatabase for the Geologic Map of the Fairfield 30 x 60 Minute Quadrangle, Idaho, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, Theresa A. Taylor, Jesse S. Bird, and Collette Gantenbein: Idaho Geological Survey, Digital Web Map (GIS) 171, 2017.

GIS Geodatabase for the Geologic Map of the Grand View-Bruneau Area, Owyhee County, Idaho, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, Alan K. Schlerf, Vance T. MacKubbin, Steve Mulberry, Tim Funderberg, and Susan Wyman: Idaho Geological Survey, Technical Report (GIS) T-93-2, 2017.

GIS Geodatabase for the Geologic Map of the Headquarters 30 x 60 Minute Quadrangle, Idaho, by Loudon R. Stanford, William R. Schuster, and Jane S. Freed: Idaho Geological Survey, Digital Web Map (GIS) 92, 2017.

GIS Geodatabase for the Geologic Map of the Idaho Part of the Grangeville 30 x 60 Minute Quadrangle, and Adjoining Areas of Washington and Oregon, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, Collette Gantenbein, Theresa A. Taylor, and Jesse S. Bird: Idaho Geological Survey, Geologic Map (GIS) 50, 2017.

- GIS Geodatabase for the Geologic Map of the Sandpoint 30 x 60 Minute Quadrangle, Idaho and Montana, and the Idaho Part of the Chewelah 30 x 60 Minute Quadrangle*, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, Theresa A. Taylor (Watt), and Jesse S. Bird: Idaho Geological Survey, Digital Web Map (GIS) 94, 2017.
- GIS Geodatabase for the Geologic Map of the Stibnite Quadrangle, Valley County, Idaho*, by Loudon R. Stanford, William R. Schuster, and Jane S. Freed: Idaho Geological Survey, Geologic Map (GIS) 51, 2017
- GIS Geodatabase for the Geologic Map of the Western Part of the Salmon 30 X 60 Minute Quadrangle, Idaho and Montana*, by Loudon R. Stanford, William R. Schuster, Jane S. Freed, and Collette Gantenbein: Idaho Geological Survey, Geologic Map (GIS) 52, 2017.
- GIS Geodatabase for the Surficial Geologic Map of Long Valley, Valley County, Idaho*, by Loudon R. Stanford, William R. Schuster, Jesse S. Bird, Dean L. Garwood, and Jane S. Freed: Idaho Geological Survey, Digital Web Map (GIS) 68, 2017.
- Seismotectonic Interpretation of the 2015 Sandpoint, Idaho, Earthquake Sequence*, by Daisuke Kobayashi, Kenneth F. Sprenke, Michael C. Stickney, and William M. Phillips: Idaho Geological Survey, Staff Report 16-1, 2016.
- Stratigraphy of the Lemhi subbasin of the Belt Supergroup*, by Russell F. Burmester, Jeffrey D. Lonn, Reed S. Lewis, and Mark D. McFadden, in John S. MacLean and James W. Sears, *Belt Basin: Window to Mesoproterozoic Earth*: Geological Society of America, Special Paper 522, P. 121-138, 2016.
- Tectonic Evolution of the Syringa Embayment in the Central North American Cordilleran Accretionary Boundary*, by Keegan L. Schmidt, Reed S. Lewis, Jeffrey D. Vervoort, Tor Stetson-Lee, Zachary D. Michels, and Basil Tikoff: *Lithosphere*, Vol. 9, No. 2, P. 184-204, 2017.
- The Mineral Industry of Idaho*, by U.S. Geological Survey, Virginia S. Gillerman, and Earl H. Bennett: U.S. Geological Survey 2012-2013 Minerals Yearbook, P. 14.0-14.5, 2016.

Abstracts

Eocene U-Pb scheelite mineralization in the Yellow Pine Au-Sb-W mining area, central Idaho, USA, by Niki E. Wintzer, Virginia S. Gillerman, and Mark D. Schmitz: Geological Society of America Abstracts with Programs, Vol. 48, No. 7, 2016.

Evidence for Neoproterozoic to Proterozoic crustal formation and modification in the northern U.S. Cordillera, by Jeff D. Vervoort, Christopher M. Fisher, Reed S. Lewis, Julia A. Baldwin, Da Wang, Andrew Jansen, Timothy Nesheim, Alex Zirakparvar, Clay McDonie, and Richard Gaschnig: Geological Society of America Abstracts with Programs, Vol. 48, No. 7, 2016.

Hydrocarbon potential of arkosic sands in the Payette Basin, southwest Idaho: a discussion on basin fill, subsurface structure, and syndepositional maturation and migration history, by Renee L. Breedlovestrout and Michael Ed Ratchford: American Association of Petroleum Geologists Datapages Search and Discovery, Article No. 90266, 2016.

Update of the Idaho Geological Survey landslide inventory, by William M. Phillips, Collette K. Gantenbein, and Loudon R. Stanford: Geological Society of America Abstracts with Programs, Vol. 48, No. 7, 2016.

Reports

Geologic Map of the Hog Cove Butte 7.5' Quadrangle, Gem and Payette Counties, Idaho, by Renee L. Breedlovestrout, Dennis M. Feeney, Reed S. Lewis, and Spencer H. Wood: Deliverable to the U.S. Geological Survey for StateMap, scale 1:24,000, May 2017.

Geologic Map of the Lemhi Pass Quadrangle, Lemhi County, Idaho, and Beaverhead County, Montana, by Russell F. Burmester, Jesse Mosolf, Loudon R. Stanford, Reed S. Lewis, Kurt L. Othberg, and Jeffrey D. Lonn: Deliverable to the U.S. Geological Survey, scale 1:24,000, May 2017.

Geologic Map of the Lewiston Plateau, by Dennis M. Feeney: Deliverable to Ralston Hydrologic Services, Inc. and TerraGraphics, scale 1:24,000, February 2017.

Geologic Map of the Smiths Ferry Quadrangle, Valley County, Idaho, by Keegan L. Schmidt, David E. Stewart, Reed S. Lewis, and William M. Phillips: Deliverable to the Idaho Transportation Department, scale 1:24,000, February 2017.

Geologic Map of the Squaw Butte 7.5' Quadrangle, Gem and Payette Counties, Idaho, by Dennis M. Feeney, Keegan L. Schmidt, Ander J. Sundell, Spencer H. Wood, Reed S. Lewis, and Renee L. Breedlovestrout: Deliverable to the U.S. Geological Survey for StateMap, scale 1:24,000, May 2017.

Geologic Map of the West Half of the Rexburg 30 x 30 Minute Quadrangle, Idaho, compiled and mapped by William M. Phillips, Daniel K. Moore, Glenn F. Embree, Dennis M. Feeney, Renee L. Breedlovestrout, Dean L. Garwood, John A. Welhan, and David J. Dougherty: Deliverable to the U.S. Geological Survey for StateMap, scale 1:75,000, May 2017.

Index of Bonnischen Geochemical Data, and Mines and Mineral Property Files uploaded to ScienceBase, by Christopher A. Tate, Dennis M. Feeney, Reed S. Lewis, and Loudon R. Stanford: Deliverable to U.S. Geological Survey National Geologic and Geophysical Data Preservation Program, September 2016.

Presentations

Depositional environments and seismic facies analysis, by Renee L. Breedlovestrout: Invited Lecture, Department of Geological Sciences, Basin Analysis Class, University of Idaho, Moscow, January 2017.

Field trip exploring the Middle Miocene in SW Idaho, Renee L. Breedlovestrout and Dennis M. Feeney: Field Trip for Hong Yang and other researchers, Western Snake River Plain, August 2016.

Geochronology of Intrusive Rocks and Hydrothermal Alteration at the Structurally Controlled Stibnite Au-Sb-W Deposit, Idaho, by Virginia S. Gillerman, Vincent H. Isakson, Mark D. Schmitz, Jeff Benowitz, and Paul Layer: China University of Geosciences, Beijing, China, December 2016.

Geologic maps as an aid to site type classification, by Reed S. Lewis: Intermountain Forestry Cooperative Annual Meeting, University of Idaho, Moscow, April 2017.

- Geology and mineralization of the Stibnite area, central Idaho*, by Reed S. Lewis and Virginia S. Gillerman: Geology Department Seminar, Eastern Washington University, Cheney, Washington, November 2016.
- Geology and mineralization of the Stibnite area, central Idaho*, by Reed S. Lewis and Virginia S. Gillerman: Montana Bureau of Mines and Geology Mining and Minerals Symposium, Butte, Montana, October 2016.
- Geology in GIS World: Confessions of a Data Nerd at the Idaho Geological Survey*, by Loudon R. Stanford: University of Idaho, Department of Geography Seminar, Moscow, November 2016.
- Geology of the Palouse*, by Dennis M. Feeney: Field trip and scientific expert, 4th grade project, Palouse Prairie Charter School, Moscow, October 2016.
- Idaho, a gas producing state! Hydrocarbon play elements of the Payette Basin, southwest Idaho*, by Renee L. Breedlovestrout: Malcom M. Renfrew Interdisciplinary Colloquium, University of Idaho, Moscow, January 2017.
- Idaho has gas to burn: hydrocarbon play element analysis in the Payette Basin, southwest Idaho*, by Renee L. Breedlovestrout: University of Idaho-Washington State University Joint Seminar Series, Pullman, Washington, February 2017.
- Idaho Minerals-related Activities*, by Virginia S. Gillerman: Idaho Geological Survey Advisory Board Meeting, Boise, November 2016.
- Idaho Mining and Exploration*, by Virginia S. Gillerman: American Exploration and Mining Association Annual Meeting, Reno, Nevada, December 2016.
- Liquefaction Susceptibility Map of the Long Valley Area, Valley County, Idaho*, by William M. Phillips: FEMA Risk MAP Public Meetings, McCall and Cascade, November 2016.
- Ore Deposits of Idaho and their Tectonic Setting*, by Virginia S. Gillerman: Development and Research Center, China Geological Survey, Beijing, China, December 2016.
- Rare Earth Elements and Geology of Lemhi Pass District, Idaho and Montana*, by Virginia S. Gillerman: Lecture, Department of Geosciences, Geology 4440/5540 Class, Idaho State University, Pocatello, March 2017.

The first producing petroleum field in Idaho's history—what we know, what we want to know, and what we may never know, by Renee L. Breedlovestrout: Idaho Section of the American Water Resources Association Brown Bag, Boise, October 2016.

Web Products

Thumbnails for Idaho Mineral Property File Scans on ScienceBase, by Christopher A. Tate: U.S. Geological Survey Data Preservation Program, March 2017.

Web Application for Mines and Prospects of Idaho, by Christopher A. Tate, Loudon R. Stanford, and Dustin Thomas: Idaho Geological Survey, November 2016.

Operational Improvements

Batch Concatenation of Mine Names to Table Indexed by Property Identifier, by Christopher A. Tate: Idaho Geological Survey, September 2016.

Batch Production of Thumbnails Based on First Page of Mineral Property File Scans using Python 2.7 and Extended Libraries, by Christopher A. Tate: Idaho Geological Survey, February 2017.

Database Objects and Controls Development for IGS Annual Mining Review (Regional Development) Reports, by Christopher A. Tate: Idaho Geological Survey, June 2017.

Geologic Map Digitizing Protocol Improvements for IGS Mapping in ArcGIS Using the NCGMP09 Standard, by Loudon R. Stanford: Idaho Geological Survey, July-December 2016.

Input or update Mines and Prospects of Idaho Database (DD-1) Property References to IGS Reference Standards, by Christopher A. Tate: Idaho Geological Survey, October 2016.

Media Interviews

Geohazards: IGS has our backs, Northwest Mining and Timber, <http://www.myvirtualpaper.com/doc/coeur-d-alene-special-sections/mining/2016112801/#0>, November 27, 2016 (M.E. Ratchford).

Idaho bill would give state sweeping power to protect oil and gas property owners, Idaho Statesman, <http://www.idahostatesman.com/news/local/news-columns-blogs/letters-from-the-west/article135729053.html>, March 1, 2017 (M.E. Ratchford).

Idaho enters ranks of hydrocarbon producing states, Oil and Gas Journal Article, <http://www.ogj.com/articles/print/volume-115/issue-2/exploration-development/idaho-enters-ranks-of-hydrocarbon-producing-states.html>, February 6, 2017 (R.L Breedlovestrout).

Idaho oil and gas industry growing; new potential areas eyed, Associated Press, <http://m.washingtontimes.com/news/2017/jan/2/idaho-oil-and-gas-industry-growing-new-potential-a/>, January 2, 2017 (M.E. Ratchford and R.L Breedlovestrout).

Professional Activities

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

Attendee, 2017 Association of American State Geologists Annual Meeting, Branson, Missouri, June 2017 (J.R. Brabb)

Attendee, Digital Mapping Techniques 2017 Workshop, Minneapolis, Minnesota, May 2017 (D.M. Feeney, L.R. Stanford, Linda Tedrow).

Affiliate Faculty, Idaho State University (J.A. Welhan).

Affiliate Faculty, University of Idaho (R. L. Breedlovestrout, V.S. Gillerman, R.S. Lewis, W.M. Phillips, M.E. Ratchford, J.A. Welhan).

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

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

Field Conference Co-Organizer, Tobacco Root Geological Society, Heise, August 2016 (W.M. Phillips).

Field Trip Leader, Tobacco Root Geological Society, Heise, August 2016 (W.M. Phillips).

Field Trip Participant, Tobacco Root Geological Society, Heise, August 2016 (R. S. Lewis, W.M. Phillips, L.R. Stanford).

Field Trip Participant and Speaker, USGS-CGS-IGS Mine Tours and Discussions on “Comparative Pacific Metallogeny and Geological Processes of Eastern China and Western USA in the Mesozoic and Cenozoic,” Beijing and Guangxi Region, China, December 2016 (V.S. Gillerman).

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

Idaho Professional Geologist (R. L. Breedlovestrout, D.M. Feeney, V.S. Gillerman, R.S. Lewis, W.M. Phillips, M.E. Ratchford).

Judge, American Association of Petroleum Geologists Pacific/Rocky Mountain Joint Meeting, Las Vegas, Nevada, October 2016 (R. L. Breedlovestrout).

Member, American Association of Petroleum Geologists (R. L. Breedlovestrout and M.E. Ratchford).

Member, American Association of Petroleum Geologists PROWESS (Professional Women in Earth Sciences Committee) (R. L. Breedlovestrout).

Member, American Association of Women Geoscientists (R. L. Breedlovestrout).

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

Member, American Geophysical Union (W.M. Phillips).

Member, Geological Society of America (R.L. Breedlovestrout, V.S. Gillerman, R.S. Lewis, W.M. Phillips).

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

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

Member, Tobacco Root Geological Society (R.L. Breedlovestrout, R.S. Lewis, W.M. Phillips, M.E. Ratchford).

Participant, American Exploration and Mining Association Annual Meeting, Reno, Nevada, December 2016 (V.S. Gillerman).

Reviewer, FONDECYT Regular 2017 grant competition, Chilean National Science and Technology Commission CONICYT, December 2016 (W.M. Phillips).

Reviewer, Lithosphere manuscript, April 2017 (R.S. Lewis).

Reviewer, USGS Data Preservation Grant Panel, April 2017 (R.S. Lewis).

Session Chair, Sedimentology & Stratigraphy: Lacustrine to Deep-Water Reservoirs, American Association of Petroleum Geologists Pacific/Rocky Mountain Joint Meeting, Las Vegas, Nevada, October 2017 (R. L. Breedlovestrout).

Short Course Participant, Geochemical Evaluation of Unconventional Shale Reservoir Systems, American Association of Petroleum Geologists, Annual Meeting, Houston, Texas, April 2017 (M.E. Ratchford and R.L. Breedlovestrout).

Short Course Participant, Introduction to Structure from Motion (SfM) Photogrammetry for Earth Science Research and Education, Geological Society of America, Denver, Colorado, September 2016 (W.M. Phillips).

Short Course Participant, Introduction to Terrestrial Laser Scanning (Ground-Based Lidar) for Earth Science Research and Education, Geological Society of America, Denver, Colorado, September 2016 (W.M. Phillips).

Technical Advisor and Participant, Governor's Meetings on BLM Sage Grouse Related Minerals Withdrawal, Idaho Office of Energy Resources, Boise, July-December 2016 (V.S. Gillerman and M.E. Ratchford).

Graduate Thesis Committees

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

Cody Parker, M.S. Geology, University of Idaho (W.M. Phillips).

Beverly Rice, Ph.D. Geology, University of Idaho (R. L. Breedlovestrout).

Bridget Wade, M.S. Geology, University of Idaho (R. L. Breedlovestrout).

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

Grants and Contracts

Additional Geologic Mapping and Study of Hydrothermal Alteration, Mineralization and Geochronology in and near Stibnite Mining District, Idaho: V.S. Gillerman and R.S. Lewis (Midas Gold Corporation, July 2014-September 2017, \$70,000).

- Big Wood River Landslide Susceptibility Mapping:* W.M. Phillips (U.S. Department of Homeland Security, Federal Emergency Management Agency, Risk MAP Program, October 2016-September 2017, \$70,098).
- Data Preservation 8:* R.S. Lewis (U.S. Geological Survey, August 2015-August 2016, \$22,025).
- Data Preservation 9:* R.S. Lewis and D. Feeney (U.S. Geological Survey, August 2016-August 2017, \$30,359).
- Geologic Mapping in the Preston, Weiser, and Salmon areas:* R.S. Lewis and D.M. Feeney (U.S. Geological Survey StateMap Program, June 2017-June 2018, \$170,165).
- Geologic Mapping in the Rexburg, Weiser, and Salmon areas:* R.S. Lewis, W.M. Phillips, and D.M. Feeney (U.S. Geological Survey StateMap Program, June 2016-May 2017, \$167,755).
- Idaho Department of Lands Abandoned Mine Lands Project, Task 3:* R.S. Lewis (Idaho Department of Lands, December 2014-February 2017, \$122,560).
- Idaho Department of Lands Abandoned Mine Lands Project, Task 4:* R.S. Lewis (Idaho Department of Lands, February 2017-February 2019, \$121,918).
- Reservoir Characterization & Petroleum Assessment of Miocene Sedimentary Rocks, southwestern Idaho:* M.E. Ratchford (U.S. Geological Survey, September 2015-August 2017, \$30,000).
- Smiths Ferry Project:* R.S. Lewis (Idaho Department of Lands, May 2015-January 2017, \$45,000).
- Surficial and bedrock mapping of Burnt Log Road corridor:* V.S. Gillerman and R.S. Lewis (Midas Gold Corporation, June 2016-September 2017, \$27,277).