

Annual Report

Fiscal Year
2020



On the Cover

Top right: IGS geologist investigates tension cracks and sand boils associated with the collapse of the inlet delta at Stanley Lake.

Bottom right: Idaho Transportation Department pilot prepares a state aircraft for departure from Upper Loon airstrip after deployment of a broadband seismometer from IGS and Boise State University personnel in response to the M6.5 Stanley earthquake of March 31st, 2020.

Bottom left: IGS geologist retrieves seismic data from one of the temporary seismic stations at Thomas Creek airstrip deployed in response to the M6.5 Stanley earthquake of March 31st, 2020.

Top left: Earthquakes during FY 2020 in Idaho and location of the temporary seismic monitoring network deployed by IGS and collaborating partners. Source: USGSANSS Comprehensive Earthquake Catalog for 07-01-2019 to 06-30-2020.

Annual Report of the Idaho Geological Survey

Fiscal Year 2020

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INTRODUCTION

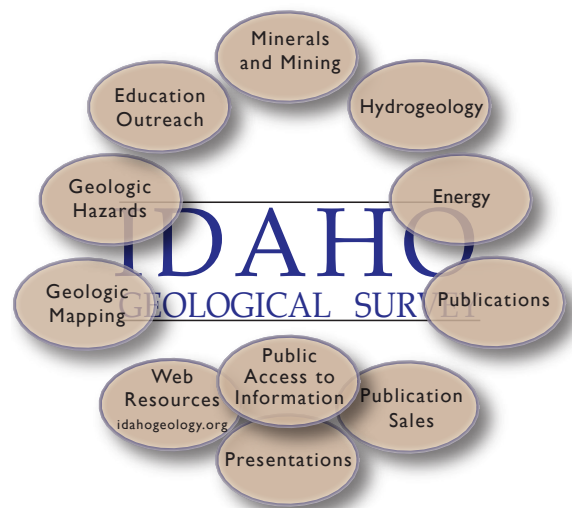
The Idaho Geological Survey (IGS) is a non-regulatory state agency that leads in the collection, interpretation, and dissemination of geologic and mineral data for Idaho. IGS is hosted by the University of Idaho. Formerly known as the Idaho Bureau of Mines and Geology, the agency has served the state since 1919.

Mission

The Survey's mission is to provide the state with timely and relevant geologic information. Members of the IGS fulfill this mission through applied geologic research and strong collaborations with federal and state agencies, academia, and the private sector. IGS research focuses on geologic mapping, geologic hazards, hydrogeology, geothermal energy, oil and gas, and metallic and industrial minerals. The Survey's Digital Mapping Laboratory is central to compiling, producing, and delivering new digital geologic maps and publications for the agency. The IGS is also engaged in dissemination of historic mining records, community service, and earth science education. As Idaho's population grows, demand is increasing for geologic and geospatial information related to energy, mineral, and water resource development, and landslide and earthquake hazards.

Vision

IGS is committed to the advancement of the geosciences and emphasizes the practical application of geology to benefit society. The Survey seeks to accomplish its responsibilities through research, service research, education, and outreach.



From the Director

Starting my new role as Director of the IGS halfway through Fiscal Year (FY) 2020, I knew there would be a steep road ahead of me, many things to learn, and great and interesting challenges to face. I would have never expected for things to turn the way they did! The months that followed my start have been marked by budget cuts, the second strongest earthquake in the recorded history of Idaho, and a global pandemic, to name a few. No matter who you are, you cannot prepare for such a scenario! You can only hope for and count on the support of a great team. Luckily, this is just what I happen to lead: a great team of dedicated scientists and professionals whose tireless effort, devotion, and camaraderie allowed IGS to not only “weather the storm” but thrive in a time of great challenges. My thanks go to all of them and to the past interim director, Dr. Peter Isaacson, and the University of Idaho administration, especially Dr. Bradley Ritts for facilitating a smooth transition with the support of the IGS Advisory Board.

Many successes have marked FY 2020: IGS celebrated its centennial anniversary, 100 years and counting of outstanding service to the state of Idaho! A vacant staff position has been filled by a brilliant and enthusiastic geologist, Russ Di Fiori, who will increase IGS’ footprint in geologic mapping and contribute new skills to IGS’ toolbox. Despite the many challenges, IGS is on track to complete all grant deliverables on time or with minimal delay. Following the magnitude (M) 6.5 earthquake on March 31st, IGS spearheaded and supported the deployment of a temporary network of seismometers to monitor the ongoing aftershock sequence. This effort has been even more fundamental in the absence of a State Seismic Monitoring Network at a time when federal agencies have experienced travel restrictions and have been unable to respond to the seismic crisis. This effort is a great example of state agencies collaborating with state universities.

All programs at IGS continue to be active, providing substantial progress toward improving our understanding of the geology of the state, and its many natural resources, hazards, and potential economic opportunities. The pages that follow are a summary of those activities. I hope you will enjoy learning of the progress made this year and about IGS’ continued, dedicated service to the state of Idaho.

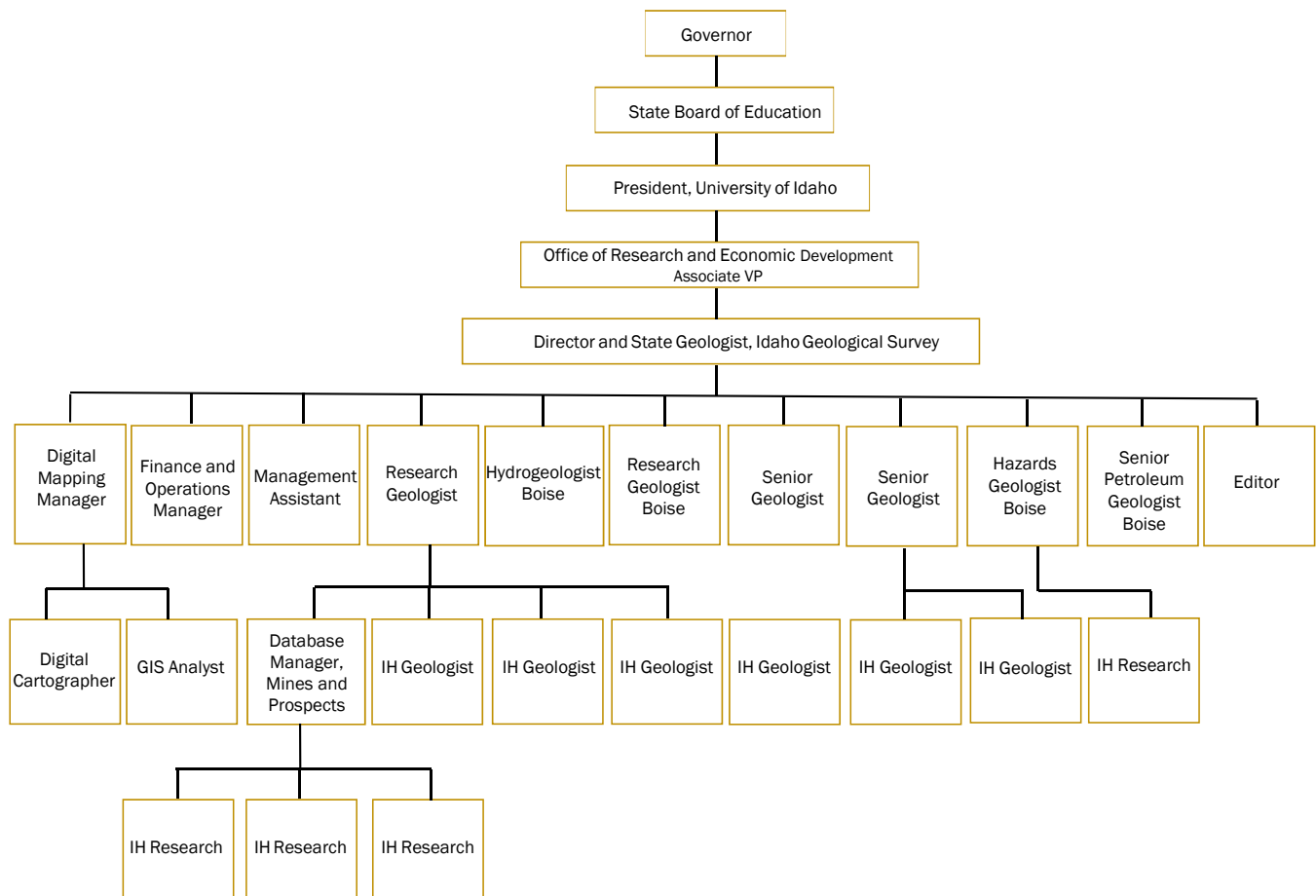
Claudio Berti
Director and State Geologist

ORGANIZATION AND PERSONNEL

The IGS provided its geological services during FY 2020 from offices in Moscow and Boise. Peter Isaacson continued his role as Interim Director from July-October 2019, and Dennis Feeney served as State Geologist from July-October 2019. In October 2019 Claudio Berti was selected as the new Director and State Geologist. Berti also served as the Interim Digital Mapping and GIS Lab Manager for the remainder of FY 2020. One vacancy was filled in FY 2020: Russ Di Fiori was hired as Senior Geologist and began his appointment in April 2020. He is stationed in Moscow.

The organization chart below represents personnel, reporting, and office locations effective during FY 2020.

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

Claudio Berti Director and State Geologist, Moscow (October 2019-June 2020)
Peter Isaacson Interim Director, Boise (July-October 2019)
Dennis Feeney State Geologist, Moscow (July-October 2019)
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 Interim Digital Mapping and GIS Lab Manager, Moscow (October 2019-June 2020)
Claudio Berti Digital Mapping and GIS Lab Manager, Moscow (July-October 2019)
Alexis Clark Hydrogeologist, Boise
Russ Di Fiori Senior Geologist, Moscow
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
Harrison Huttanus Work Study
Beverly Rice Research Assistant
Wes Sandlin Research Assistant
D. Kate Schalck Geologic Editor
Keegan L. Schmidt Geologist
William Schuster Research Assistant
David E. Stewart Geologist
Eric D. Stewart Geologist

Idaho Geological Survey Advisory Board

Ex Officio: Claudio Berti – Chair

Director & State Geologist
Idaho Geological Survey
(October 2019-June 2020)

Ex Officio: Peter Isaacson – Chair

Interim Director
Idaho Geological Survey
(July-October 2019)

Leslie Baker

Chair, Department of Geological Sciences
University of Idaho

Susan Cleverly

Mitigation Section Chief
Idaho Office of Emergency Management

Benjamin Crosby

Chair, Department of Geosciences
Idaho State University

Chris Dail

Exploration Manager
Midas Gold Idaho, Inc.

David Hawk

Representative
Office of the Governor

James “Jim” McNamara

Chair, Department of Geological Sciences
Boise State University

Dan Moore

Professor, Department of Geology
Brigham Young University - Idaho

Mick Thomas

Oil and Gas Division Administrator
Idaho Department of Lands
(appointed September 2019)

Rich Reed

President
Idaho Association of Professional Geologists

Idaho Geological Mapping Advisory Committee

Dale Kerner – Chair
Permitting Manager
Midas Gold Idaho, Inc.

Shawn Enright
District Geologist
Idaho Transportation Department

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

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

Joe Larsen
Geologist
Mining Law Program Lead
Bureau of Land Management

Sean Long
Associate Professor
Earth Sciences
Washington State University

Jonathan Moore
Project Geologist
Hecla Silver Valley, Inc.

Shawn Nield
State Soil Scientist
Natural Resources Conservation Services

Dennis Owsley
Technical Hydrogeologist
Idaho Department of Water Resources

David Pearson
Assistant Professor
Department of Geosciences
Idaho State University

John Rice
President
Rocky Mountain Environmental Associates, Inc.

Lydia M. Staisch
Research Geologist
U.S. Geological Survey
Geology, Minerals, Energy, and Geophysics Science Center

Diane Wheeler
Forest Geologist
Caribou-Targhee National Forests

Katie Wilkes
Mine Geologist
JR Simplot Co., Smoky Canyon Mine

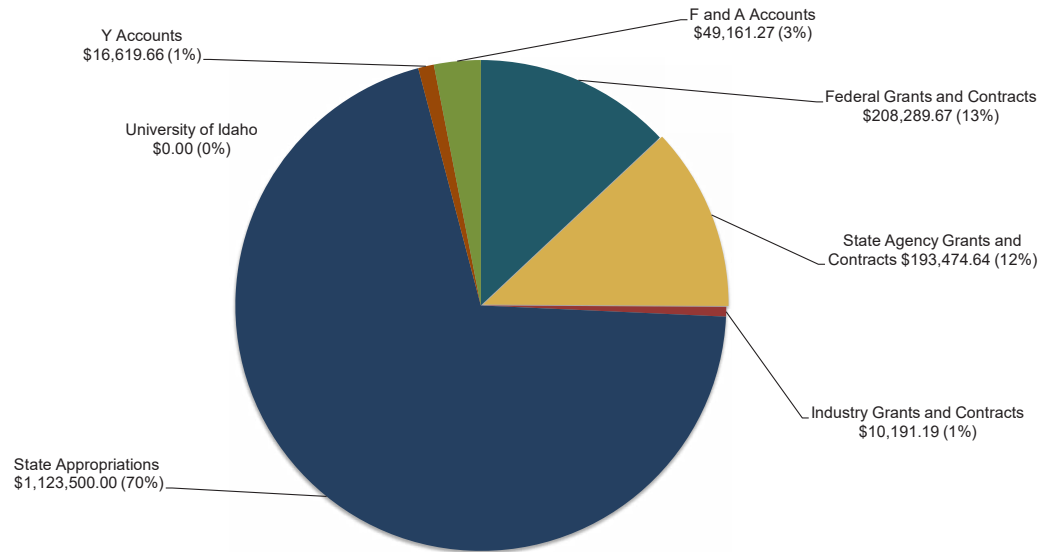
FISCAL OVERVIEW

In FY 2020, 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 2020 was \$1,123,500, a \$38,400 increase from \$1,085,100 in FY 2019. This increase is due to adjustments in personnel and one-time funding allocations.

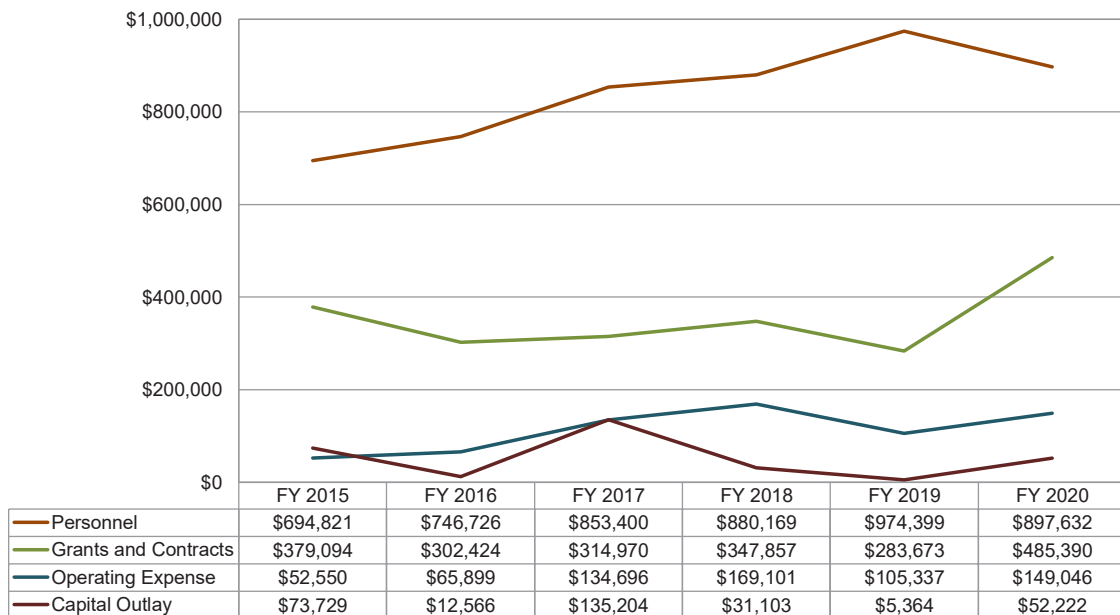
Grant and contract expenditures increased from \$283,673 in FY 2019 to \$483,108 in FY 2020 due to snow cover extending into the field season in several research areas causing the majority of summer field work in 2019 to occur after the start of FY 2020. Expenditures came from 15 projects in FY 2020 compared to 14 projects in FY 2019. The \$483,108 in expenditures came from grants awarded in FY 2020 and multi-year grants awarded in FY 2019. In FY 2020, IGS acquired extramural funding from ongoing sources, such as the U.S. Geological Survey (USGS) and Idaho Department of Lands (IDL), as well as a new award from the Idaho Water Resources Board for a one-year hydrogeologic investigation of the Raft River Valley.

The Legislature funded FY 2020 at a level consistent with FY 2019 salary, related benefits, and operations base budget with a moderate 3% cost of living increase. The legislature approved a capital outlay request for \$8,600 of one-time funding for equipment replacement. During FY 2020 the state has requested that IGS refund a 1% (\$11,200) spending reset, a 1% (\$11,200) COVID-19 pullback, and a \$2,200 sick leave pool drawback.

Budget for Fiscal Year 2020					
Category	Beginning Balance	Income or Appropriation	Actual	Expense	Ending Balance
Personnel	-	\$ 1,081,900.00	\$ 897,632.39	\$ 897,632.39	-
Operating Expense	-	\$ 33,000.00	\$ 140,445.55	\$ 140,445.55	-
Capital Outlay	-	\$ 8,600.00	\$ 8,600.00	\$ 8,600.00	-
Total Appropriations	-	\$ 1,123,500.00	\$1,046,677.94	\$ 1,046,677.94	\$ 76,822.06
UI Personnel Funds	-	-	-	-	-
Y Accounts	\$ 49,364.98	\$ 33,458.00	\$ 16,619.66	\$ 16,619.66	\$ 66,203.32
F and A Accounts	\$ 81,246.71	\$ 23,314.00	\$ 49,161.27	\$ 49,161.27	\$ 55,399.44
Grants and Contracts	\$ 214,132.50	\$ 646,013.00	\$ 483,108.20	\$ 483,108.20	\$ 377,037.30
TOTAL	\$ 344,744.19	\$ 1,826,285.00	\$1,595,567.07	\$ 1,595,567.07	\$ 575,462.12



Sources of funding, FY 2020.



Trends in expenditures, FY 2015-2020.

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.

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; Raft River Valley)	Idaho Transportation Department (Landslide Inventory Database) Integra Resources (De Lamar and Swisher Mountain mapping) IRIS PASSCAL (seismic stations) U.S. Geological Survey (Statemap Program; Data Preservation; NEHRP Earthquake Hazard Program; Earth MRI) Wilmat Petroleum Company (Yellow Pine mapping)
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Collaborators

American Exploration and Mining Association	Integra Resources
American Geophysical Union	Intermountain Forestry Cooperative
American Geosciences Institute	Instrumental Software Technology, Inc.
American Water Resources Association, Idaho State Section	IRIS PASSCAL
Arizona Geological Survey	Latah County Library
Association of American State Geologists	Lehigh University
American Assoc of Petroleum Geologist	Lettis Consultants International
Belt Association	Lewis-Clark State College
Boise State University	Moscow Charter School
Brigham Young University-Idaho	Midas Gold
California Polytechnic State University	Missouri State University
Center for Advanced Energy Studies	Montana Bureau of Mines and Geology
China Geological Survey	Nevada Bureau of Mines and Geology
China University of Geosciences	Northwest Knowledge Network
College of Idaho	Oregon Department of Geology and Mineral Industries
College of Western Idaho	Orma J. Smith Museum of Natural History
Earthquake Engineering Research Institute	Owyhee Gem and Mineral Society
Federal Emergency Management Agency	Snake River Oil and Gas
Franklin and Marshall College	Schlumberger Petroleum Services
Geological Society of America	Society of Mining Engineers, Boise Section
Geomark Laboratories	Spokane Community College
Governor's Office, State of Idaho	Tobacco Root Geological Society
Hecla Mining Company	U.S. Bureau of Land Management
Hells Canyon Gem Club	U.S. Bureau of Reclamation
High Mesa Holdings	U.S.D.A. Agriculture Research Service
Horse Heaven Syndicate	U.S. Forest Service
Ice Age Floods Institute	U.S. Geological Survey—Minerals Program
Idaho Department of Fish and Game	U.S. Geological Survey—NEHRP
Idaho Department of Environmental Quality	U.S. Geological Survey—Water Resources Division
Idaho Department of Lands	U.S. Geological Survey—Data Preservation
Idaho Department of Water Resources	U.S. Geological Survey—Earth MRI Program
Idaho Environmental Forum	U.S. Geological Survey—NCGMP
Idaho Ground Water Monitoring Technical Committee	UNAVCO
Idaho Historical Society	University of Alaska, Fairbanks
Idaho Mining Association	University of Idaho
Idaho Museum of Mining and Geology	University of Montana
Idaho Office of Emergency Management	University of Potsdam
Idaho Office of Energy Resources	Utah Geological Survey
Idaho Oil and Gas Conservation Commission	Washington Division of Geology and Earth Resources
Idaho Public Television	Washington State University
Idaho Science Teachers Association	Western State Colorado University
Idaho State University	Western States Seismic Policy Council
Idaho Transportation Department	Wyoming Geological Survey
Idaho Water Resources Research Institute	Yellowstone Volcano Observatory

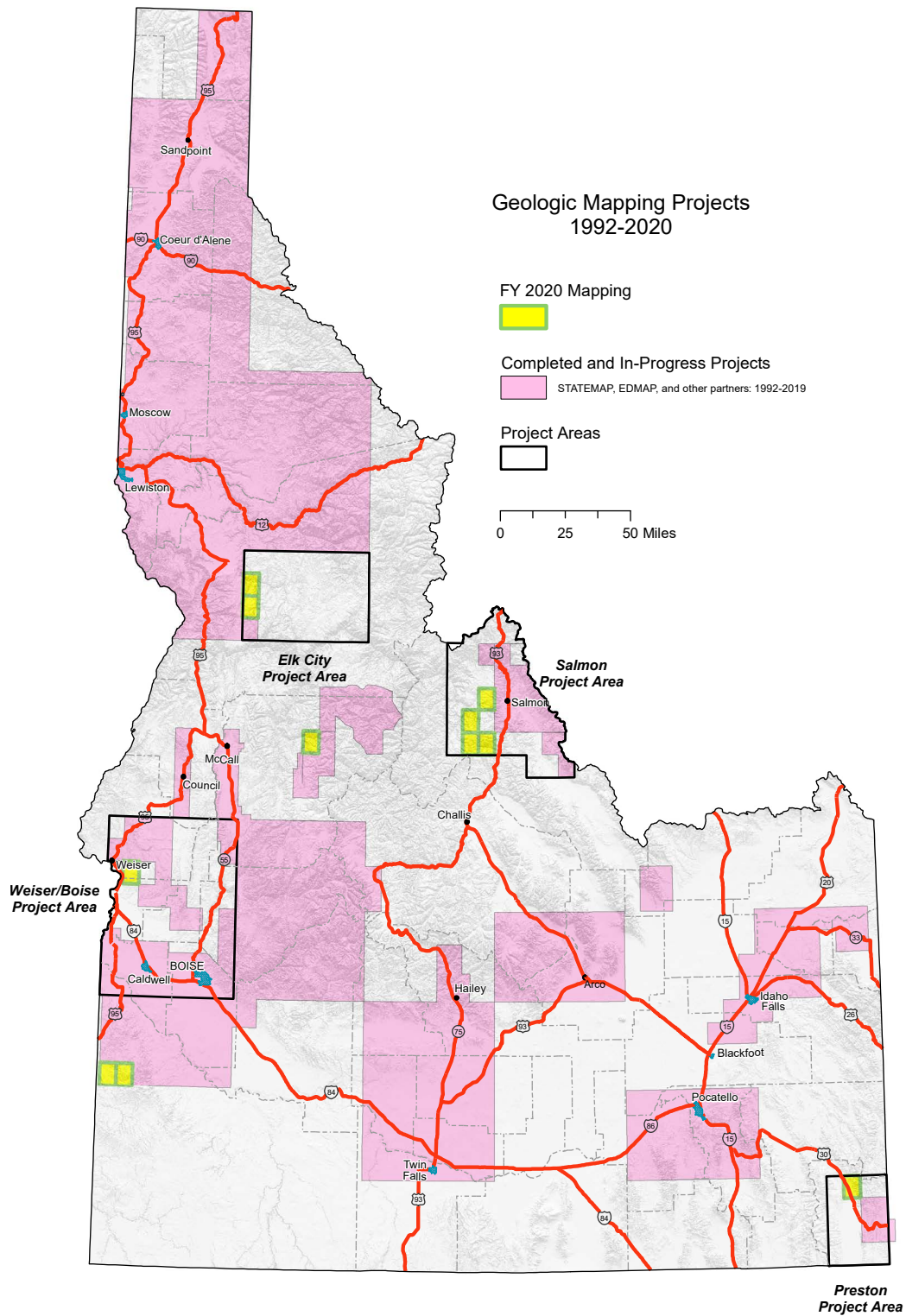
RESEARCH

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

Geologic map products from the IGS are a critical tool for communicating and distributing foundational geologic information to Idaho's constituents. The Survey has been mapping in areas selectively to address development impacts in urban settings, assess possible new geologic resources, and identify and monitor geohazards such as earthquake seismicity and landslides. The Idaho Geologic Mapping Advisory Committee (IGMAC) helps the IGS with Idaho's geologic mapping needs and long-term planning for geologic mapping. IGS primarily focuses on mapping 7.5' and 30' x 60' quadrangles, and these geologic map products are utilized by a diverse suite of stakeholders in a variety of tasks. These tasks include defining groundwater resources by delineating aquifer boundaries; identifying and categorizing geological materials for engineering needs; aiding in roadway design, construction, and maintenance; identifying seismic and landslide hazards; defining precious and industrial mineral potential; assisting with timber management; and assessing geologic resources on public lands, which include federal lands, parks, recreation areas, and state endowment lands. In addition, they provide the basis for understanding the geologic evolution of the state.

Funding for Idaho's geologic mapping program is shared by the Statemap component of the USGS National Cooperative Geologic Mapping Program (NCGMP) and the Survey. Since 1993, Idaho has received over \$4.47 million in federal funds and matched an equal amount of "in kind" salaried employee's participation to complete geologic mapping in Idaho. In FY 2020, new mapping was conducted in the Elk City, Preston, Salmon, and Weiser-Boise project areas, where Survey geologists mapped five 7.5' quadrangles (Sawyer Ridge, Hungry Ridge, Georgetown, Leesburg, and Weiser Cove). One 7.5' quadrangle map from the Salmon project area (Ulysses Mountain) was published, as was a map from the Weiser-Boise project area (Crane Creek Reservoir).



Progress of the geologic mapping effort in Idaho, 1992-2020.

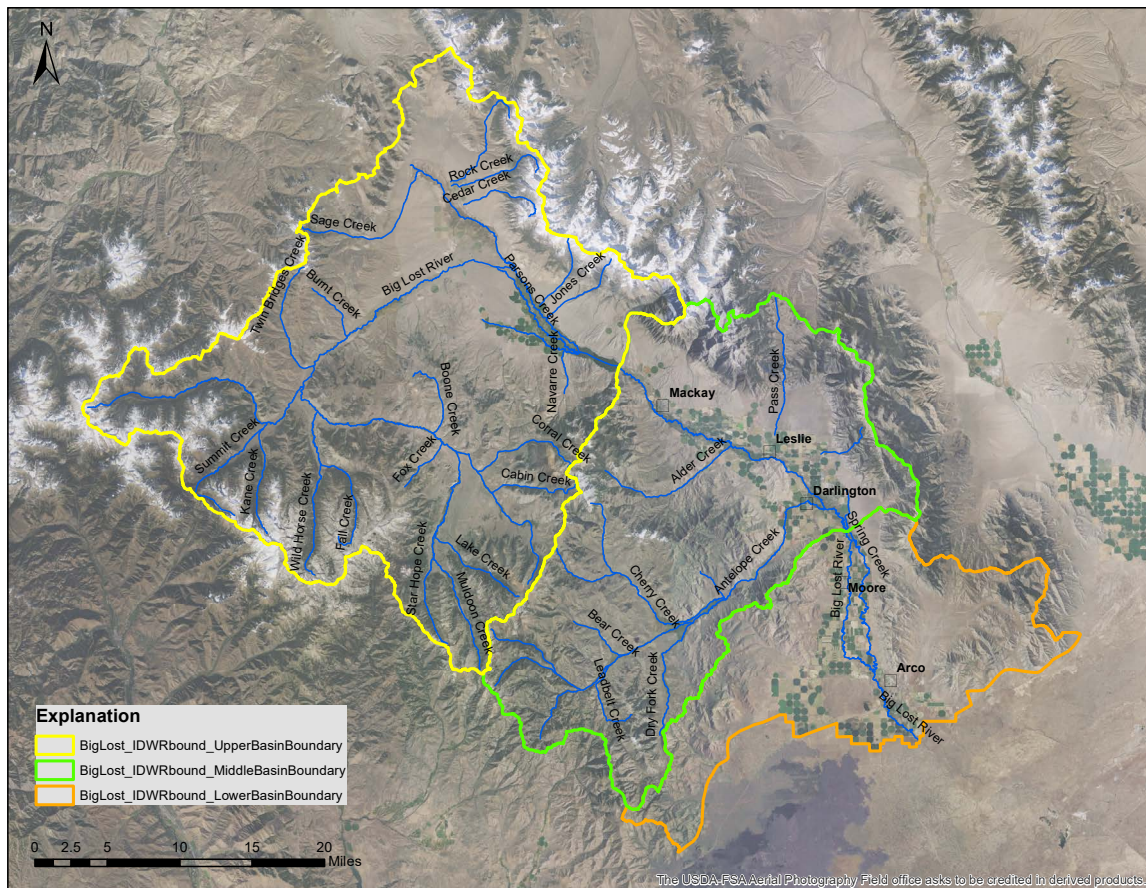
In an effort to reduce the country's dependence on foreign-sourced minerals that are fundamental to our security and economy, the USGS developed the Earth Mapping Resources Initiative (Earth MRI). The IGS received Earth MRI funding in FY 2020 to begin a two-year mapping program in the Idaho cobalt belt near Salmon. Both cobalt and rare-earth elements (REEs) are the focus of this effort.

Industry-funded geologic mapping was also conducted by the IGS. The Horse Heaven Syndicate funded mapping of the Yellow Pine quadrangle in central Idaho, work that complements our previous mapping of the adjacent Stibnite quadrangle to the east funded by Midas Gold. Integra Resources funded the geologic mapping of two 7.5' quadrangles, De Lamar and Swisher Mountain, at and northwest of the DeLamar gold and silver mine in southwest Idaho. (More details are provided in the *Mineral Resources and Mining* section.)

Hydrogeology

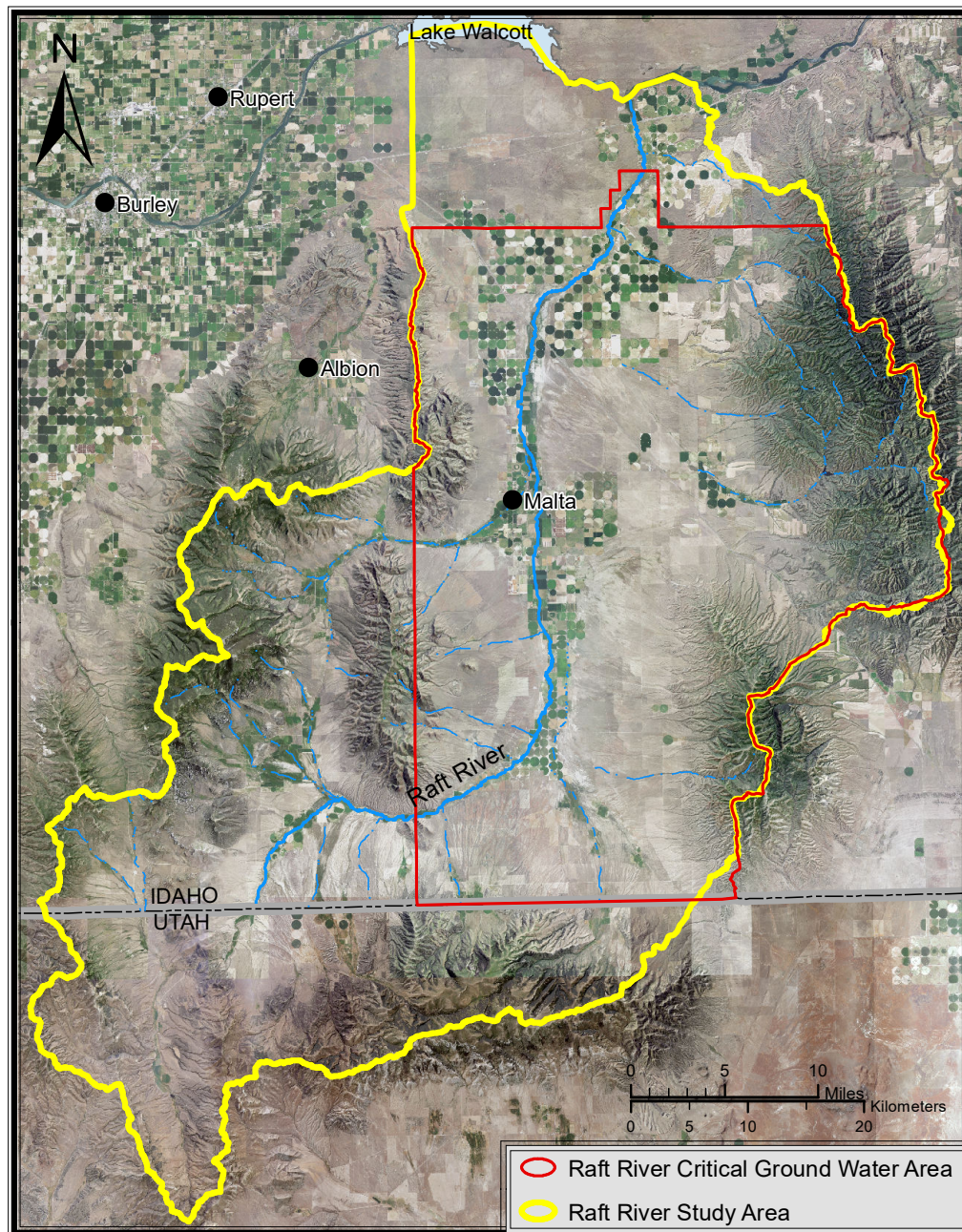
Hydrogeologic activities performed by IGS during FY 2020 included continued work on water budgets for the Big Lost River Valley in east-central Idaho and initiation of a one-year hydrogeologic investigation in the Raft River Valley in south-central Idaho. Both basins support agricultural resources for the state and are tributary to the Eastern Snake Plain Aquifer (ESPA). IGS also continued public service, outreach, and education in FY 2020 on the state's geology and groundwater resources.

Under a cooperative agreement with the Idaho Department of Water Resources (IDWR) as the project lead, IGS is preparing groundwater budgets at a watershed scale for the Big Lost River Valley groundwater study. Separate water budgets will represent dry, wet, and average water years. Ultimate project goals are to characterize the basin hydrogeology, estimate groundwater underflow to the Idaho National Laboratory, support calibration efforts by IDWR of the existing ESPA numerical groundwater flow model, and provide data and interpretation for decision makers and water right accounting processes. The USGS is preparing the hydrogeologic framework for the basin and is conducting seepage run surveys of the Big Lost River. The results of the groundwater budgets will be presented as a chapter in a comprehensive USGS report, scheduled for publication in Fall 2021.



Big Lost River, south-central Idaho, project study extent.

IGS, together with IDWR and the Idaho Water Resources Research Institute (IWRRRI), commenced a one-year hydrogeologic investigation during FY 2020 of the Raft River Valley. Declining groundwater level trends over several decades starting in the 1950s and 1960s, currently on the order of about 0.61 to .91 meters (2-3 feet) per year in some areas, have reduced the available basin yield. Project objectives are to compile existing hydrogeologic datasets, perform field reconnaissance in support of future data collection, and identify perceived data gaps with recommendations for future investigations. IGS is conducting this work between November 2019 and November 2020 with Idaho Water Resource Board funding, totaling \$107,500. The results of the investigation will be summarized in a brief memorandum, and supporting datasets and information are being published on IDWR's project website, available at <https://idwr.idaho.gov/water-data/projects/raft-river/>.



Raft River, south-central Idaho, project study extent.

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

As the state's population continues to rapidly grow and infrastructure expands, the risk of damage caused by geologic hazards 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 2020, IGS continued its geologic hazards program in several ways:

- Identify and map geologic hazards such as landslides and active faults to provide 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.
- 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 the U.S. Federal Emergency Management Agency (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

In absence of a state-operated seismic monitoring network, IGS stays informed about earthquakes in and around Idaho through seismic monitoring performed by the USGS, Montana Bureau of Mines and Geology, University of Utah, Idaho National Laboratory, and the Pacific Northwest Seismic Network.

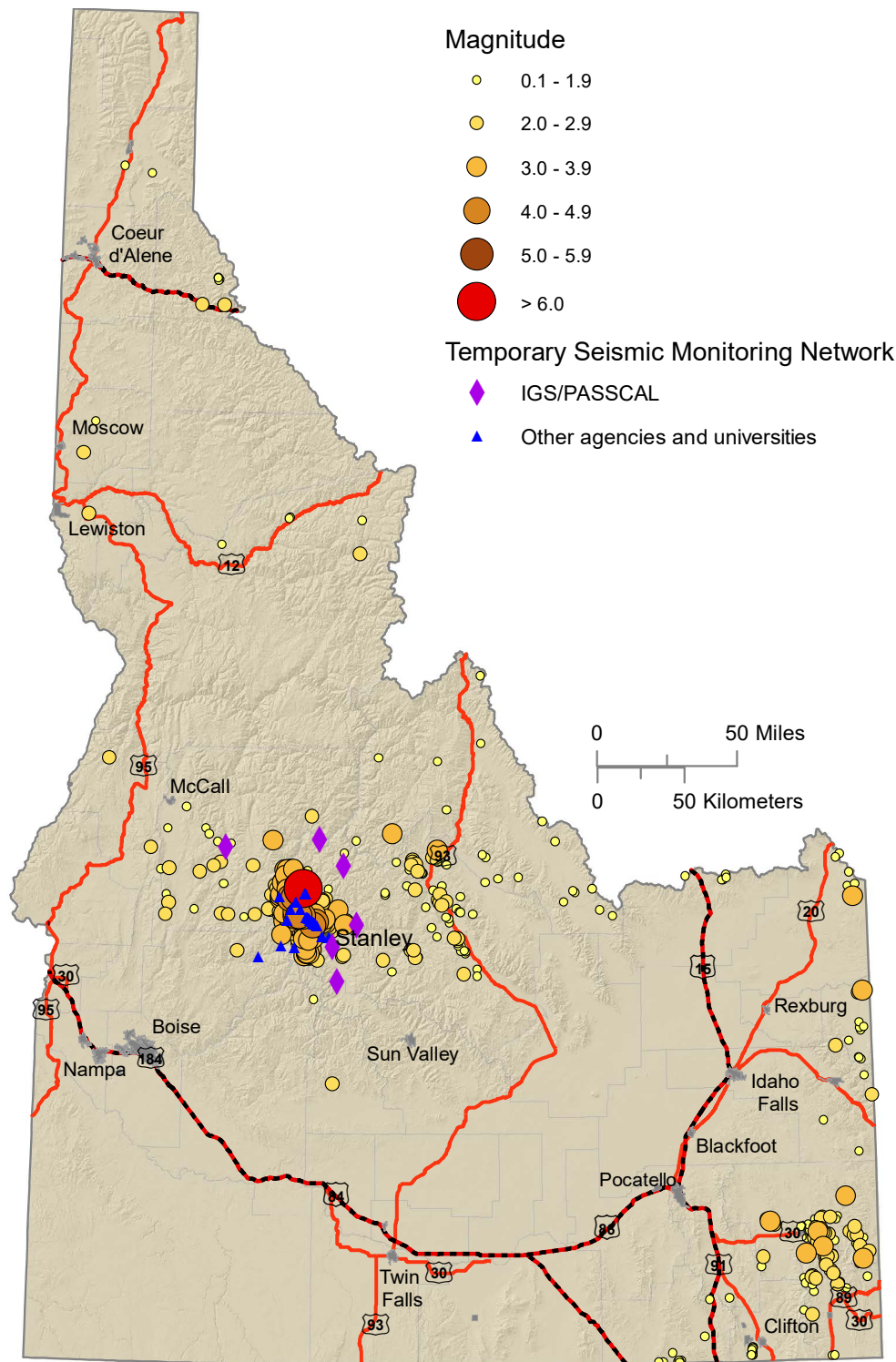
Significant seismic activity occurred in Idaho during FY 2020. On March 31, 2020 a magnitude (M) 6.5 earthquake occurred approximately 30 kilometers (18.64 miles) north-northwest of Stanley, Idaho. This was the second largest earthquake to occur within Idaho in recorded history. The mainshock was followed by an aftershock sequence that continues to produce M3 and M4 earthquakes. Immediately after the mainshock, IGS secured seismic instrumentation through Incorporated Research Institutions for Seismology Portable Array Seismic Studies of the Continental Lithosphere Instrument Center (IRIS PASSCAL) and partnered with Boise State University (BSU) scientists to deploy and maintain a network of temporary seismometers to record the aftershock activity.

Shaking from the M6.5 Stanley earthquake was felt widely across the western U.S., but no major damage or injuries were reported. Due to heavy snowpack in the mountains near the epicenter, the shaking triggered numerous snow avalanches. Shaking also caused rockfall and toppled several rock formations in the Sawtooth Mountains that hosted popular climbing routes. Liquefaction and lateral spreading caused by the mainshock or early aftershocks was observed at Stanley Lake, where the inlet delta collapsed and disappeared into the lake. Parts of the shoreline flooded due to subsidence of the marshy sediments near the inlet.

In response to the Stanley earthquake, the Survey conducted aerial reconnaissance flights, deployed and maintained seismometers, visited Stanley Lake to map liquefaction, provided scientific information to the Idaho Office of Emergency Management, gave interviews to regional media outlets, posted timely information on social media, co-authored a peer-reviewed journal article, built and managed a virtual clearinghouse for scientific data, and hosted webpages with summaries of the earthquake event and the liquefaction event.

Landslides

Landslides, debris flows, and alluvial fan floods occur frequently in Idaho's mountainous landscapes. Transportation networks such as highways



Earthquakes during FY 2020 in Idaho and location of the temporary seismic monitoring network deployed by IGS and collaborating partners. Source: USGS-ANSS Comprehensive Earthquake Catalog for 07-01-2019 to 06-30-2020.

and railroads are particularly vulnerable to these hazards since they are often located in narrow canyons along rivers and streams.

Relatively few major landslides were reported in Idaho during FY 2020. IGS records and maps landslide occurrence throughout the state. In FY 2020 the Survey continued 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. The inventory database will be available to the public in December 2020.

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, Montana State University, and the geological surveys of Idaho, Wyoming, and Montana. IGS is a regular contributor to the Caldera Chronicles, a weekly, public-facing newsletter highlighting the science of the Yellowstone area.

In FY 2020, no volcanic eruptions occurred in Idaho. However, normal levels of seismicity related to Yellowstone volcanic activity occurred throughout FY 2020.

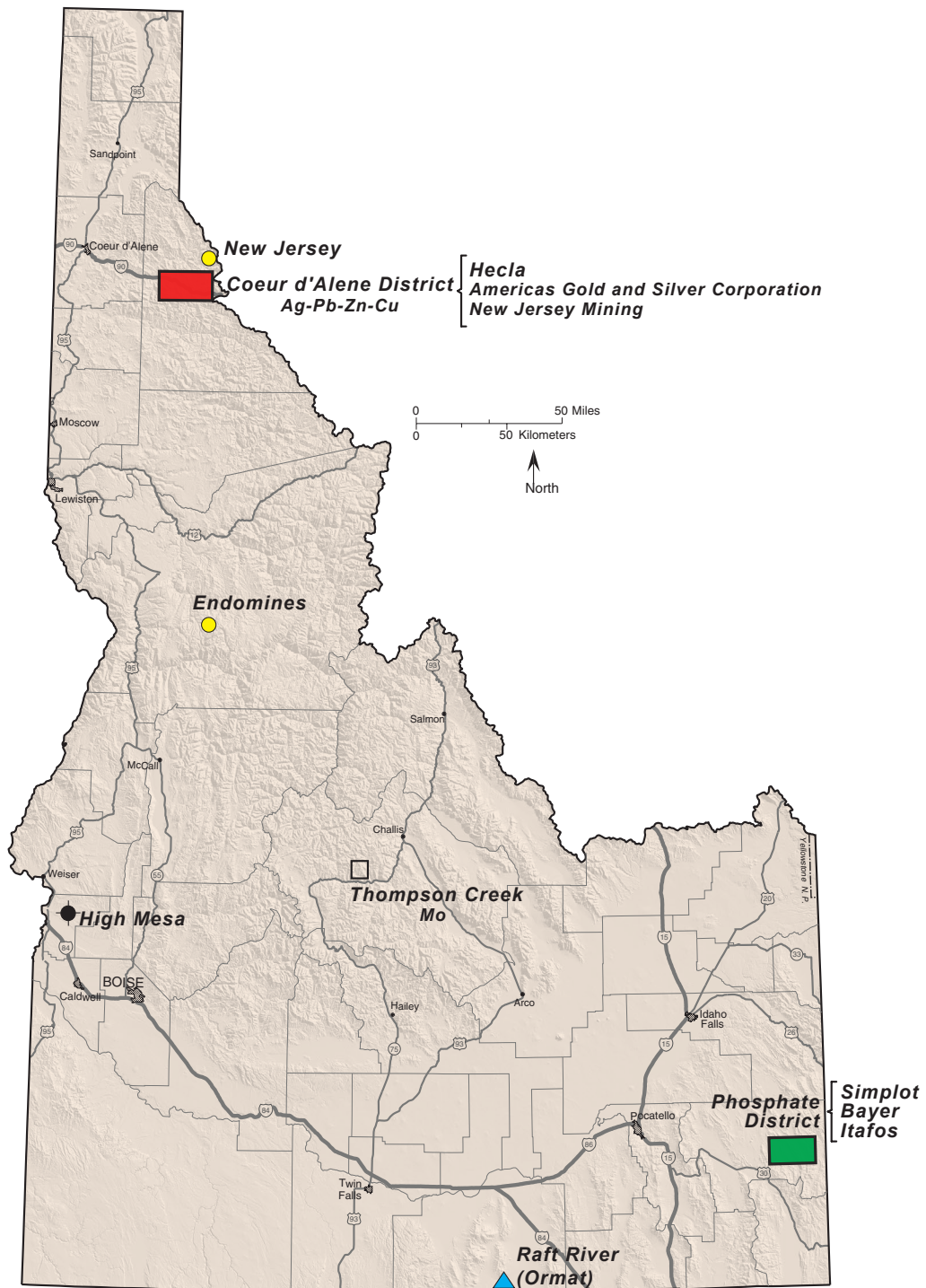
Mineral Resources and Mining

Active Mining and Exploration

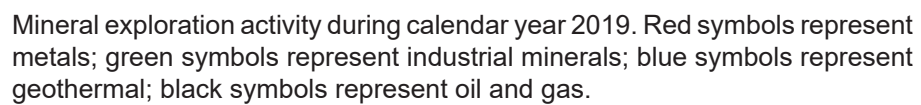
The IGS continued to annual research and report on Idaho's mineral industry, extending decades of such work that provides timely exploration information and historical records to assist the public, government agencies, and industry. Through a collaboration with the USGS, Idaho's information is part of the Idaho chapter of the Minerals Yearbook, a global compilation of developments and statistics on mining and minerals. In December, the minerals activity summary for calendar year 2019 was presented at the American Exploration and Mining Association (AEMA) annual convention in Reno and shortly thereafter posted on the IGS website. Exploration activity was increasing in the last half of 2019 before the COVID-19 pandemic impacted the mining industry, which was declared an essential industry. Mining and exploration continued to be strong at the end of FY 2020, driven in part by high precious metal prices.

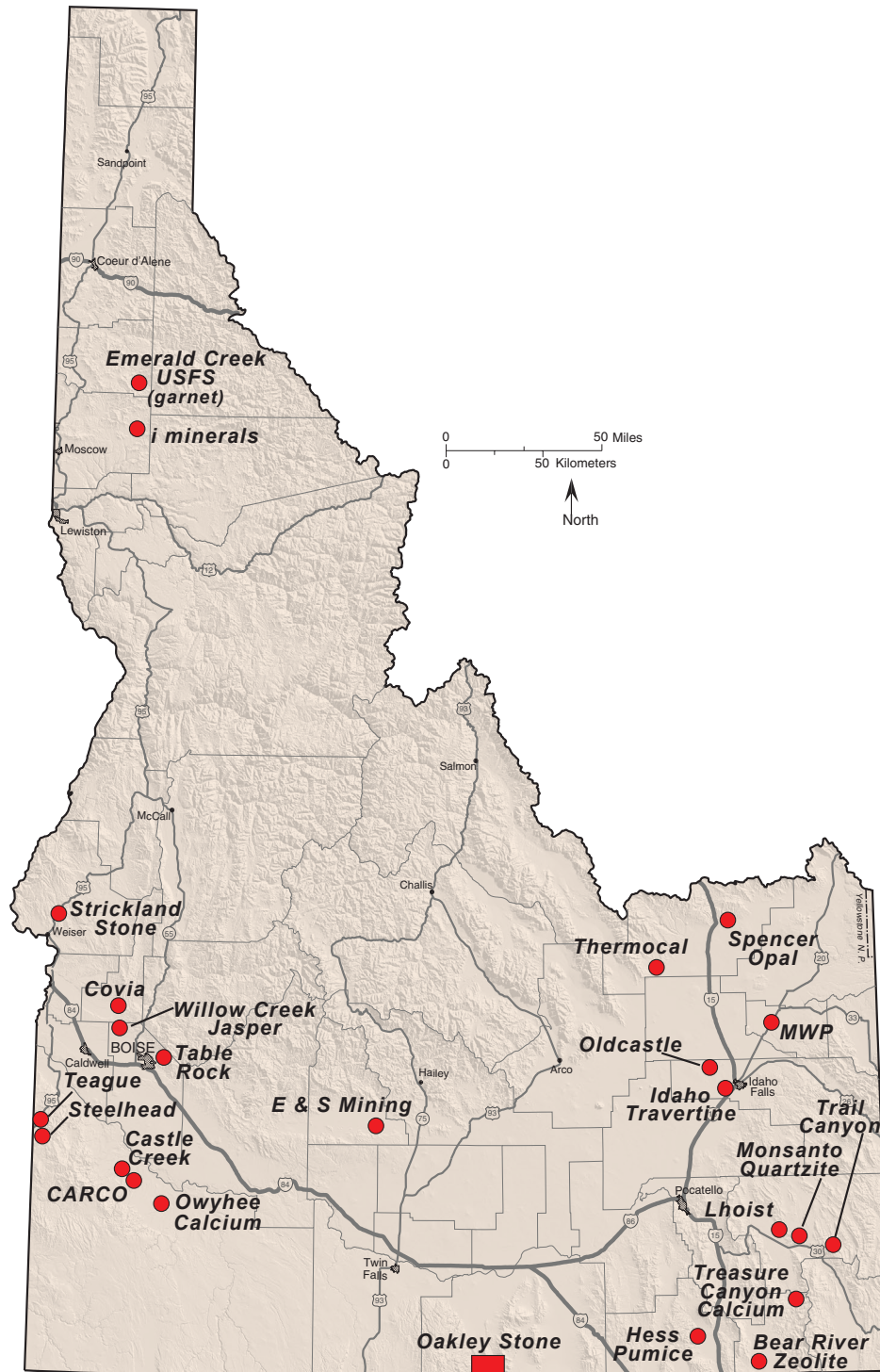
In FY 2020, mining continued as in FY 2019 with major operations located in the greater Coeur d'Alene district of north Idaho and the Phosphate Reserve of southeastern Idaho. Phosphate mining by Bayer, Simplot, and Itafos continued. New phosphate mine plans were approved for Bayer's Caldwell Canyon mine and Simplot's Dairy Syncline mine, both of which are large projects with decades of new mine-life. Striking workers at Hecla Mining's Lucky Friday mine ratified an agreement in early January 2019, finally ending the two and a half-year strike. Hecla announced that the silver-lead underground mine at Mullan would return to full production by the end of 2020. At the Galena mine, a \$20 million investment by a new joint venture partner funded major infrastructure improvements and increased exploration drilling by Americas Gold and Silver Corporation. The Bunker Hill Mining Corporation worked to secure funding and announced a shift to silver exploration in 2020. At Murray, locally owned New Jersey Mining Company operated the Golden Chest mine, the state's only producing gold mine in 2019. However, a Finnish company, Endomines was soon producing gold at their new Friday underground mine near Elk City. Increasing gold and silver prices were also fueling robust exploration by the summer of 2020, despite COVID-19 slowdowns.

Exploration continued in FY 2020 with gold being the major focus with silver also of interest. Due to a decline in the price of cobalt, activity in Idaho's Cobalt Belt decreased to just two major projects, Jervois Mining's Idaho Cobalt Operation at the RAM deposit in the Blackbird district, and First Cobalt's Iron Creek project. Jervois acquired the project in July 2019, when they purchased eCobalt. Midas Gold's Stibnite project was in the NEPA permitting stage for its mining and restoration plan with the U.S. Forest Service. Large advanced drilling and development projects were underway by Revival Gold at the Beartrack mine and Arnett Creek properties in Lemhi County, by Otis Gold at Kilgore in Clark County, by Liberty Gold at the Black Pine mine in Cassia County, and by Integra Resources at the DeLamar and Florida Mountain mines in Owyhee County. Smaller projects included polymetallic targets, such as drilled by BeMetals at South Mountain and by Phoenix Copper at the Empire mine at Mackay. Idaho Champion drilled at the Baner gold mine near Elk City and later in the year acquired the former Champagne gold mine west of Arco in Butte County. There was a small amount of grass roots exploration.



Active Mines and Plants during calendar year 2019. Red and yellow symbols represent metals; green symbols represent industrial minerals; blue symbols represent geothermal; black symbols represent oil and gas.





Industrial mineral operations active during calendar year 2019.

Minerals-Related Research

DeLamar Mapping Project

The major mineral-related research project was the geologic mapping that started in June 2019 with funding from Integra Resources Corporation. The Survey is conducting 1:24,000 scale regional geologic mapping of the De Lamar and Swisher Mountain quadrangles. The area includes the past-producing DeLamar and Florida Mountain mines which are the focus of Integra's exploration activity. The previous operations closed in 1999 during a time of very low gold prices. A preliminary compilation of the mapping was completed during the winter and early spring, as were initial petrographic investigations. The field mapping during 2019 confirmed the complexity of the volcanic stratigraphy and structure. Mineralization, which was well-described by Lindgren in 1898, consists of epithermal veins hosted in and cutting the rhyolites and underlying basement rocks. Silicified sediments and hot spring deposits are localized along a northerly to northwest-trending corridor west of the DeLamar mine.

Other Minerals-Related Research

IGS conducted research in support of the USGS-lead Earth MRI Critical Minerals project with descriptions and documentation on availability and deposit potential of critical minerals in Idaho. A critical minerals of Idaho geodatabase was created from the Survey's Mines and Prospects database and the geological literature and expertise of staff. This project is part of the Data Preservation grant funded by the USGS. Minerals information was also provided to the Nez Perce-Clearwater Forest Plan Revision in cooperation with the U.S. Forest Service and the Idaho Office of Energy and Mineral Resources.



View of Florida Mountain open pit hosted in rhyolite and quartz latite with basalt outcrop in foreground.



Silicified sediment and sinter with casts, Swisher Mountain Quadrangle.

Energy

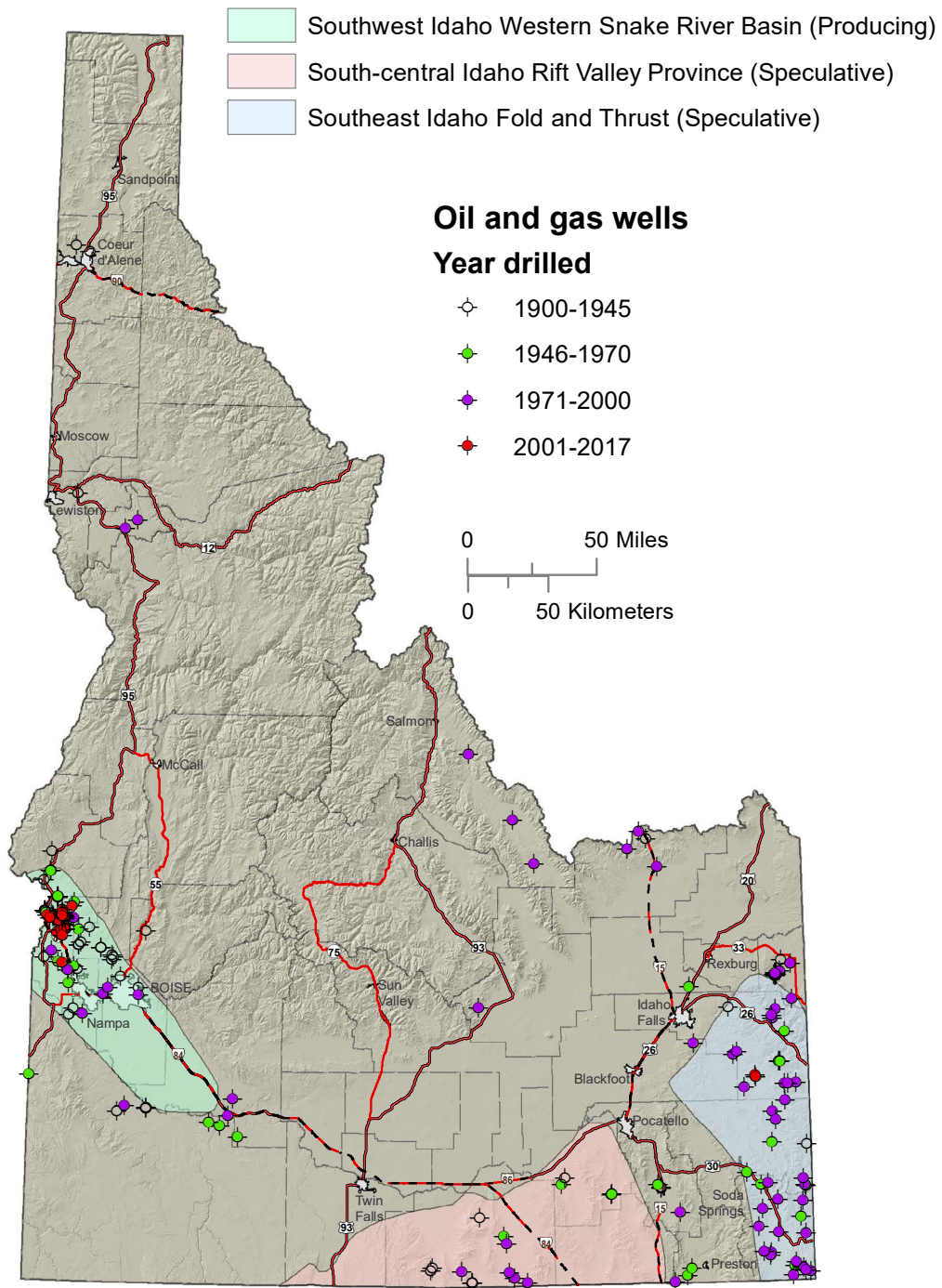
Oil and Gas

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. IGS achieves this goal through:

- Conducting primary research on the formation and occurrence of proven and possible petroleum systems.
- Providing new information that highlights the exploration potential of frontier, underexplored, or inactive basins.
- 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 2016, Idaho completed its first full year of commercial oil and gas production, making it the 31st U.S. state to produce hydrocarbons. Production is concentrated in the southwestern part of the state where conventional accumulations of condensate, gas, and oil, have been encountered beneath the Western Snake River Plain. Approximately 800,000 barrels of condensate/oil and more than 283 million cubic meters (10 billion cubic feet) of natural gas have been produced from the Willow and Hamilton Fields. Future production from the Harmon Field is pending construction of a pipeline tying producing wells to the Little Willow processing facility. Currently, Snake River Oil and Gas is the primary operator and lease holder having acquired the assets from High Mesa Holdings (a subsidiary of Alta Mesa Resources) in 2020.

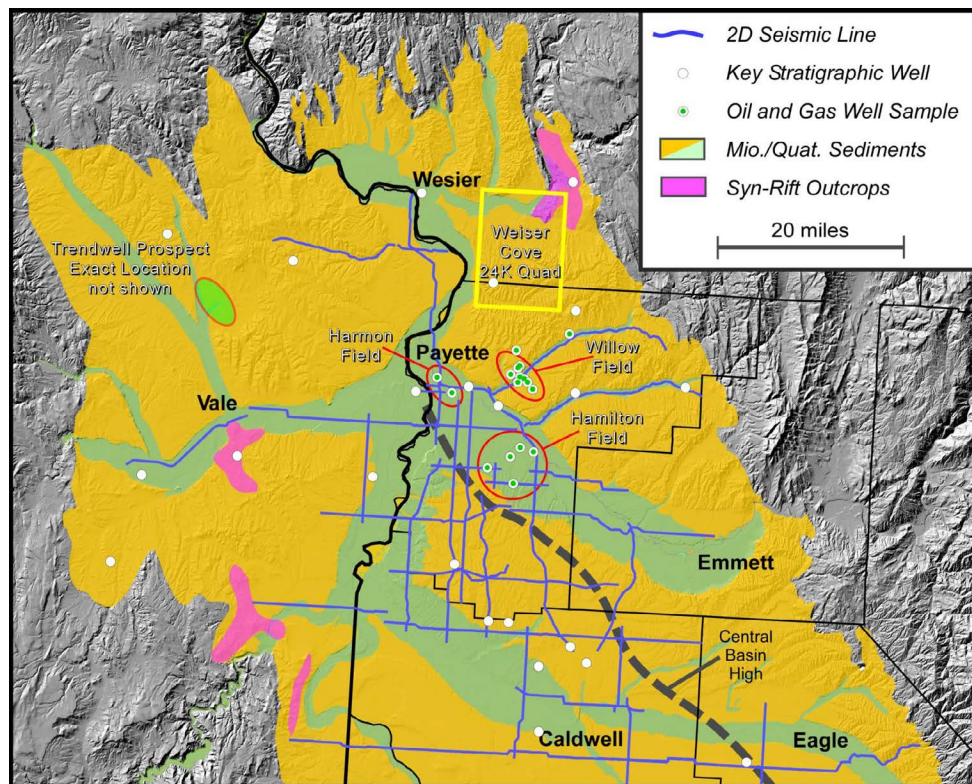
In addition to the Western Snake River Plain, there are other poorly explored areas in Idaho which presently are nonproducing but have many geologic characteristics in common with productive basins elsewhere and may represent a part of future oil and gas production within the state. The IGS has identified 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



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

play in southwest Wyoming. The south-central play is highly speculative and defined by the potential association of several well-known source rocks with Cenozoic age metamorphic core complexes.

Collaborations between the IGS and industry representatives has been instrumental in obtaining access to subsurface data that otherwise would not be available. The Oil and Gas program has also been supported by petroleum modeling software (Schlumberger's Petrel Exploration & Production Platform, Schlumberger's PetroMod Petroleum Systems Modeling Software) made available to the Survey and the University of Idaho from industry partnerships.



Map of Western Snake River Plain illustrating data available for researching the underlying petroleum system.

In 2015, the IGS was awarded a five-year research grant from the USGS to conduct reservoir characterization and petroleum assessment of recently discovered resources in the southwestern part of the state. In FY 2020 a final report was delivered to the USGS synthesizing the main findings on geochemical characterization of gas condensate.

Basin Analysis of the Western Snake River Plain

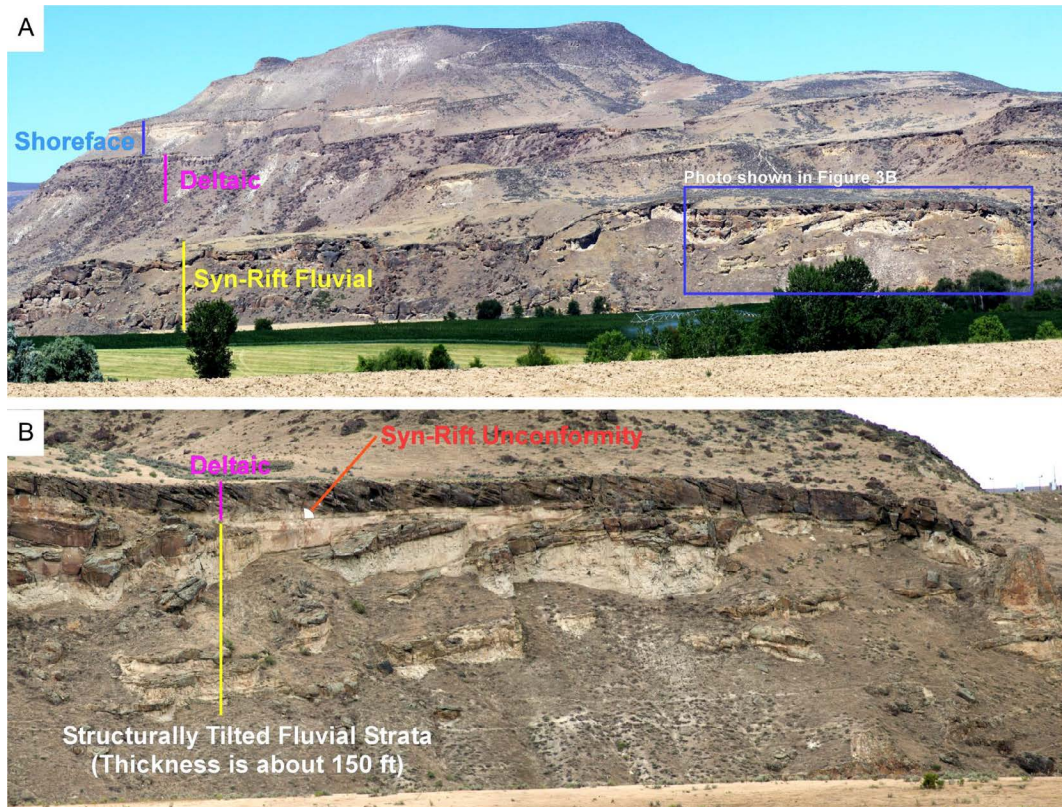
Basin analysis is a methodology that integrates data (well, seismic, outcrop) at the regional scale to define the tectonic and stratigraphic framework of the basin fill and its evolution through time. The results provide a basis for describing the petroleum system in terms of reservoir, seals, and source rocks needed for identifying which areas are most likely to produce hydrocarbons and assessing the hydrocarbon potential of the basin. Current work involves the integration of new well information with regional 2D seismic lines in Payette County. Longer-term objectives include the construction of a Basin Scale 3D model that will assist future subsurface activity relating to oil and gas, groundwater, gas storage, geothermal, and waste disposal.

Bedrock Geological Mapping along the northern margin of the Western Snake River Plain

In October 2019, as part of the IGS Statemap effort, field mapping was completed of the Weiser Cove 7.5' quadrangle in Washington County. The area includes exposures of stratigraphic units directly analogous to producing zones within the subsurface at the Willow and Harmon fields located 24.14 kilometers (15 miles) to the south and southeast.

Outcrop Analog Studies of Western Snake River Plain Reservoirs

Seismic-scale, syn-rift outcrops located on the margin of the Western Snake River Basin are being investigated as analogs for assessing the size and internal complexity of nearby producing subsurface reservoirs. Drone-based photogrammetry has been utilized as tool for building virtual outcrop models that illustrate and document complex structural and stratigraphic relationships which can be accessed in an office environment. Information from the outcrops integrated with subsurface and field production data will be used to constrain production forecasts of undrilled prospects.



A) View of Mitchell Butte located on the southwest margin of the Western Snake River Plain. Outcrops are interpreted to be analogs for producing reservoirs at the Willow and Harmon Fields in Idaho.

B) Close-up of Mitchell Butte outcrop showing structurally tilted fluvial sandstones and siltstones that have been top truncated by flat-lying fluvial-lacustrine deposits.

Origin of Hydrocarbons from the Western Snake River Plain

The goal of this study is to address the origin and generation of produced hydrocarbons (natural gas, condensate, light oil) through an investigation of their geochemical and isotopic characteristics. Gas and fluid samples from fourteen wells have been collected and analyzed for geochemical composition, biomarkers, and isotopic signatures. Results to date indicate the hydrocarbons from the Willow Field were likely sourced from terrestrial organic material and generated at a depth of approximately 1,524-2,133.60 meters (5,000-7,000 feet).

Source Rock Quality and Distribution

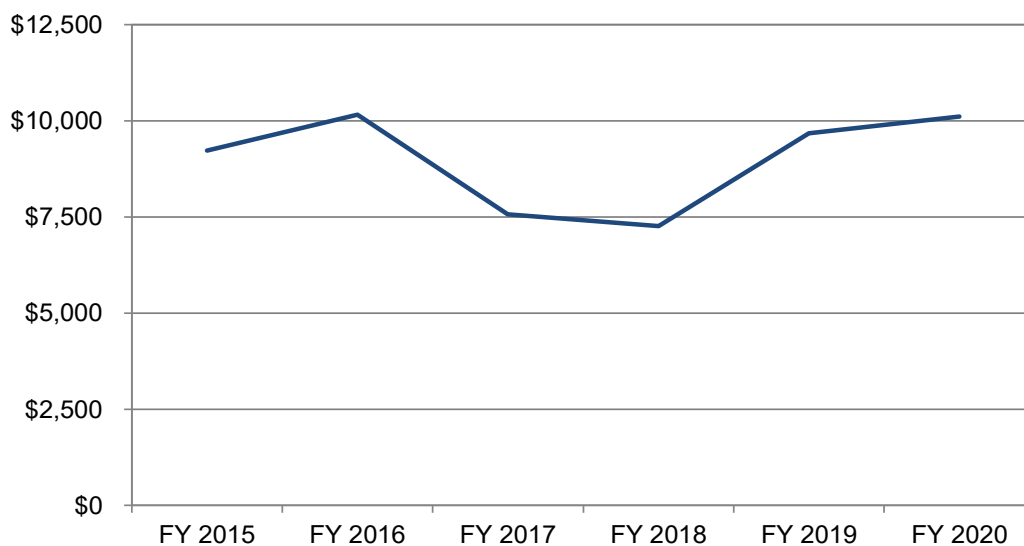
This project seeks to identify and characterize hydrocarbon generating capabilities of potential source rocks within the Western Snake River Basin. Well cuttings of organic-rich zones from eight wells have been collected and analyzed from the point of view of organic matter type, maturity, and Rock-Eval pyrolysis. Data will provide information on which subsurface zones are capable of generating hydrocarbons.

OUTREACH

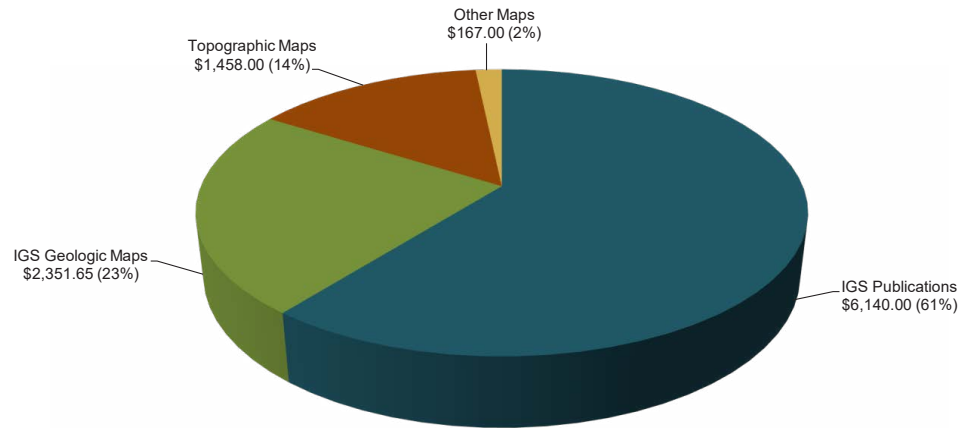
The Survey disseminates geologic data on Idaho primarily through IGS publications, the agency website, social media, in-house collections, and efforts by the staff to educate the public in the earth sciences.

Publications

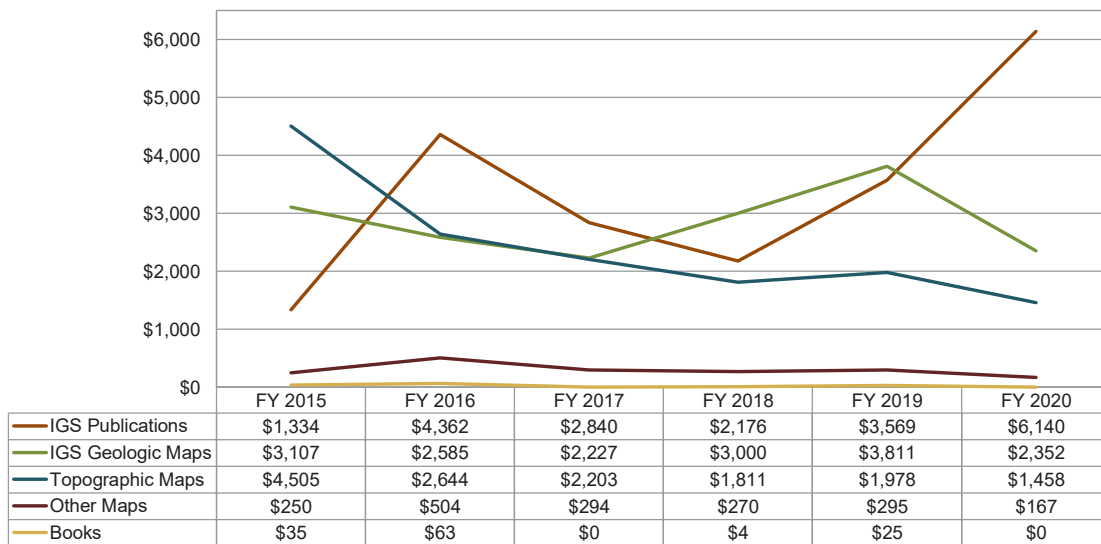
In FY 2020 publication sales increased by 4.5% from the previous year. IGS Publications, which include Bulletins, Mines and Prospects Maps, Staff Reports, Technical Reports, Pamphlets, and select field guides, outsold other types of publications, accounting for 61% of total sales in FY 2020. Since its release in 2012, the *Geologic Map of Idaho* has continued to be the best selling IGS publication. Nearly all publications are available for free download on the IGS website.



Total publication sales, FY 2015-2020.



Publication sales by sales category, FY 2020.



Publications sales by sales category, FY 2015-2020.

Website

www.idahogeology.org

The IGS website provides the public easy access to agency publications and data. Nearly all of Survey publications (over 1,000) are available for download at no cost. IGS also offers interactive web map apps to search, locate, and download documents and data. Web app updates are detailed in the Databases and Archives section. In FY 2020 more than 278,000 website visits were logged. Five new Survey publications were posted on the website this year which include several geologic maps and a GeoNote publication. In response to the Stanley earthquake two new webpages, Stanley Earthquake and Stanley Lake Liquefaction, were created with summaries of these events.

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 2020 our Facebook posts reached over 12,342 Facebook users. On Twitter, IGS tweeted or retweeted 121 times and currently has 1,862 followers.

The M6.5 March 31st earthquake near Stanley, Idaho was an excellent example of how valuable a social media presence is for a state research agency. Within minutes of the earthquake IGS began live-tweeting personal accounts of the event, scientific data, news reports, and best practices for earthquake safety. According to analytics provided by Twitter, in April 2020, IGS tweeted 42 times, garnered 2,652 profile visits, gained 87 new followers, and made 93,400+ tweet impressions. This is our most significant social media outreach month to date.

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 map projects were established in support of the Statemap effort and most of the digitizing completed. Final products were delivered in the early months of FY 2021 due to COVID-19 extension on the USGS grant. Work in support of the

Earth MRI initiative included progress on the map and database of the map compilation in the Idaho Cobalt Belt. Progress has been made on several backlogged publications, and the lab expects to be able to release several new products in FY 2021.

The lab continues to compile geology from around the state in geologic map databases to meet compliance with the USGS Geologic Map Schema (GeMS). Much progress was made this year toward meeting compliance with the GeMS standard. IGS GIS staff actively participated in technical discussion and contributed pieces of code and valuable troubleshooting to the nationwide GeMS community.

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. Over 200 new references were added, and over 50 existing references were reviewed resulting in the addition of nearly 100 new properties and impacting location and commodities for over 850 distinct properties. Five additional hours of audio-visual footage were processed bringing the total to 94 geolocated clips discoverable and available for download via the Mines web app and for streaming through the IGS' YouTube channel. Functionality for searching Mines and Prospects documents by company name was added to the Mines web app, and six filters were developed to expand searching properties by popular attributes, such as placer sites and properties with known ore-processing facilities. Over 15,500 mine maps, unpublished reports, documents, and other geolocated mining-related media are now available through the Mines web app.
- A critical minerals of Idaho geodatabase was created to assist identifying areas of known and potential strategic resource deposits of critical interest for the nation. These data are informed in part by the ongoing reference review work underway for the Mines and Prospects database and are being shared with the USGS Earth MRI project.
- Forty-six additional unpublished and out-of-print Regional Development reports and presentations were processed and added

to the Current and Historic Mining Activity webpage for download completing our collection of these valuable resources for years 1965-2019. Idaho State Annual Mine Inspector Reports years 1899 and 1900 were scanned and made available for download as part of an ongoing effort to provide a complete collection (1899-1974) of these difficult to locate publications to the public.

- An effort to digitize and post the IGS' collection of nearly 200 Idaho-related out-of-print or unpublished U.S. Atomic Energy Commission documents and microfiche began. These materials are extremely difficult or impossible to locate, and many contain data related to current critical minerals interest.

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 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 north Idaho and teachers on our mailing list who continually use these kits. The IGS participated in the “Geologic Map Day” event during Earth Science Week by highlighting the recently published *Geologic Map of the Hawley Gulch Quadrangle, Bonneville and Madison Counties, Idaho* on the IGS website and social media. In 2019 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.

From the Apennines to the Andes: a summary of rambling geology, Claudio Bert: Seminar series, Department of Geological Sciences, University of Idaho, Moscow, October 2019.

Geologic mapping in the Miocene Weiser volcanics; Idaho's full-suite volcanic field in Columbia River Basalt Country, Dennis M. Feeney: Boise State University Department of Geosciences Seminar, October 2019.

Idaho Geological Survey Exhibit, Kristen Pekas: Idaho STEM Together Conference, Coeur d'Alene, August 2019.

Idaho Geological Survey Exhibit, Reed S. Lewis, Claudio Berti, D. Kate Schalck, and Christopher A. Tate: Northwest Federation of Mineralogical Societies Annual Convention and Show, Lewiston, October 2019.

Idaho Geological Survey Exhibit, Reed Lewis, Virginia Gillerman, and Alexis Clark: Owyhee Gem and Mineral Show, Caldwell, March 2020.

Introduction to Lidar for Geohazards, Zach Lifton: FEMA funded workshop, Moscow, August 2019.

Science Fair Judge, Alexis Clark: Boise State University STEM Event, Boise, March 2020.

Seminar Series Committee Member, Dennis M. Feeney: University of Idaho Department of Geological Sciences, Moscow, August 2019-May 2020.

The Boardwalk to Nowhere, Claudio Berti: U.S. Forest Service Outreach Signage, Stanley Lake, May 2020.

PUBLICATIONS AND ACTIVITIES

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Geologic Map of the Bayhorse Anticline, Custer County, Idaho, by Daniel T. Brennan, David M. Pearson, Paul K. Link, and Kevin R. Chamberlain: Idaho Geological Survey Technical Report 20-01, scale 24,000, 2020.

Geologic Map of the Crane Creek Reservoir Quadrangle, Washington County, by Dennis M. Feeney and Keegan L. Schmidt: Idaho Geological Survey Digital Web Map 187, scale 1:24,000, 2019.

Geologic Map of the Southern Portion of the Clayton Quadrangle, Custer County, Idaho, by Nicholas J. Krohe, Daniel T. Brennan, Paul K. Link, David M. Pearson, and L. Trent Armstrong: Idaho Geological Survey Technical Report 20-02, scale 24,000, 2020.

Geologic Map of the Ulysses Mountain Quadrangle, Lemhi County, Idaho, by Reed S. Lewis, Russell F. Burmester, and Jeffrey D. Lonn: Idaho Geological Survey Digital Web Map 188, scale 1:24,000, 2019.

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The Yellowstone Hotspot and Columbia River Basalts, by Zach Lifton: Yellowstone Volcano Observatory Caldera Chronicles, 2019.

What's with all these Earthquakes? And will they affect Yellowstone?, by Mike Poland, Jamie Farrell, Zach Lifton, and Mike Stickney: Yellowstone Volcano Observatory Caldera Chronicles, 2020.

Abstracts

Building a modern digital landslide database for Idaho, by Zachery M. Lifton, Scott Ducar, and Dave Richards: Northwest Geotech Workshop, 2019.

Episodic Hydrothermal Processes in Au-Sb-W Deposits of the Stibnite District, Idaho, USA: The Value of In-Situ Techniques, by Virginia S. Gillerman, Mark D. Schmitz, and Christopher Dail: Geological Society of America Abstracts with Programs, v. 51, no. 5, 2019.

Fluid Inclusion Evidence for the Temperature and Composition of Ore Fluids in the Lemhi Pass and Diamond Creek REE-Th Districts, Idaho-Montana, by Grace K. Allison, Martin S. Appold, Virginia S. Gillerman, and Hector M. Lamadrid: Geological Society of America Abstracts with Programs, v. 51, no. 5, 2019.

Geohazard assessment of mass movements along railroad corridors with UAV LiDAR, by Donna Delparte, Zachery Lifton, and Matthew Belt: European Geosciences Union General Assembly, 2020.

Sequence Stratigraphy, Play Analysis and Reservoir Prediction within a Lacustrine Intracratonic Rift Basin, Western Snake River Plain, Idaho, by Mark Barton: American Association of Petroleum Geologist Rocky Mountain Section Annual Meeting, 2019.

The Impact of Extensional Tectonics on the Evolution of Lacustrine Successions During the Early Stages of Rifting: The Western Snake River Basin, Idaho, by Mark Barton: American Association of Petroleum Geologists Annual Convention and Exhibition, 2020.

Reports

Abandoned Mine Lands Work Progress Report, by Reed S. Lewis and Christopher A. Tate: Progress Report to Idaho Department of Lands, December 2019.

Critical Minerals in Idaho, by Virginia Gillerman: Idaho Geological Survey memo to Idaho Office of Energy and Mineral Resources, October 2019.

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Geochemical geodatabase of Idaho, by Dennis Feeney, Reed S. Lewis, and Christopher A. Tate: Deliverable to U.S. Geological Survey National Geological and Geophysical Data Preservation Program, August 2019.

Geodatabase of regional strategic and critical mineral occurrences in Idaho, by Reed S. Lewis, Virginia S. Gillerman, and Christopher A. Tate: Deliverable to U.S. Geological Survey National Geological and Geophysical Data Preservation Program, December 2019.

Geology of Cascade Lake State Park, by Dennis M. Feeney: Deliverable to the Idaho Department of Parks and Recreation, January 2020.

Geology of Eagle Island State Park, by Ander Sundell: Deliverable to the Idaho Department of Parks and Recreation, December 2019.

Geology of Thousand Spring State Park, by Dennis M. Feeney: Deliverable to the Idaho Department of Parks and Recreation, December 2019.

Geology of Three Island Crossing State Park, by Dennis M. Feeney: Deliverable to the Idaho Department of Parks and Recreation, January 2020.

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Petroleum geochemistry: Insights into the origin of natural gases and fluid hydrocarbons from the Western Snake River Plain, Idaho by Mark Barton and Michael E. Ratchford: Final Report for the U.S. Geological Survey, April 2020.

Polygons of Critical Minerals in Idaho, by Virginia Gillerman, Christopher Tate, and Reed Lewis: Part of Deliverable Product for USGS Earth MRI grant, December 2019.

Progress Report Year 1, Geologic Mapping of DeLamar and Swisher Mtn. Quadrangles project, by Virginia S. Gillerman: Idaho Geological Survey memo to Integra Resources, April 2020.

Presentations

2019 Update of Activities, by Virginia S. Gillerman: Idaho Geological Survey Advisory Board Meeting, Moscow, November 2019.

Argos, Excel, and Pivot Tables, by John Brabb: University of Idaho Department Grant Administrators, Moscow, September 2019.

Episodic Hydrothermal Processes in Au-Sb-W Deposits of the Stibnite District, Idaho, USA: The Value of In-Situ Techniques, by Virginia S. Gillerman, Mark D. Schmitz, and Christopher Dail: Geological Society of America Annual Meeting, Phoenix, Arizona, September 2019.

Geologic mapping as it relates to mineral and hydrocarbon exploration in Idaho, by Reed S. Lewis: Society for Mining, Metallurgy, and Exploration Meeting, Boise, March 2020.

Geothermal Resource Development in Idaho – A Current Overview, by Alexis Clark, Geothermal Systems in Sedimentary Basins Conference, Edmonton, Canada, October 2019.

Geothermal Resource Development in Idaho – A Current Overview, by Alexis Clark: Idaho Association of Professional Geologists, Boise, December 2019.

Idaho Earthquakes and Seismic Hazards Activity, by Zach Lifton: 2020 Basin and Range Earthquake Working Group Meeting, Salt Lake City, Utah, February 2020.

Idaho Geological Survey Financial Report, by John Brabb: Idaho Geological Survey Advisory Board Meeting, Moscow, November 2019.

Idaho Geological Survey Geohazards FY19 Overview, by Zach Lifton: Idaho Geological Survey Advisory Board Meeting, Moscow, November 2019.

Idaho Geological Survey Hydrogeology Program Update, by Alexis Clark: Ground Water Monitoring Technical Committee, Boise, December 2019.

Idaho Geological Survey Hydrogeology Program Update, by Alexis Clark: Idaho Geological Survey Advisory Board Meeting, Moscow, November 2019.

Idaho Geological Survey Oil and Gas Program Update, by Mark Barton: Idaho Geological Survey Advisory Board Meeting, Moscow, November 2019.

Idaho Geological Survey Oil and Gas Program, by Mark Barton: Idaho Oil and Gas Conservation Commission Meeting, Boise, February 2020.

Idaho Mining and Exploration, 2019, by Virginia S. Gillerman: American Exploration and Mining Annual Meeting, Reno, Nevada, December 2019.

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

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Mines and Prospects database data entry interfaces for general attributes, company names, and Current and Historic Mining Data, including autogenerated metadata, by Christopher A. Tate: Idaho Geological Survey, January 2020.

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‘The floor was moving’: 6.5 earthquake strikes in Idaho, largest in the state since 1983, USA Today, <https://www.usatoday.com/story/news/nation/2020/03/31/earthquake-idaho-the-whole-house-rattling/5100853002/>, April 1, 2020 (Idaho Geological Survey).

What do Idaho scientists know about the fault at the center of dozens of earthquakes?, Idaho Statesman, <https://www.idahostatesman.com/latest-news/article243916062.html>, June 30, 2020 (C. Berti).

What the delta that disappeared at Stanley Lake could tell us about future earthquakes, Idaho Statesman, <https://www.idahostatesman.com/latest-news/article243879232.html>, June 29, 2020 (C. Berti).

What’s with all these earthquakes? And will they affect Yellowstone?, Yellowstone Caldera Chronicles/Billings Gazette, <https://www.usgs.gov/center-news/whats-all-these-earthquakes-and-will-they-affect-yellowstone>, April 6, 2020 (Z.M. Lifton).

Professional Activities

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

Affiliate Faculty, University of Idaho (M.D. Barton, C. Berti, V.S. Gillerman, R.S. Lewis, Z.M. Lifton).

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

Board Member, Western Snake River Plain Geothermal Project (M.D. Barton).

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

Expert, Idaho Jurisdictional Risk Assessment (Z.M. Lifton).

Expert, Idaho Office of Emergency Management Annual Executive Committee Meeting, Boise, November 2019 (Z.M. Lifton).

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

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

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

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

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

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

Member, American Geophysical Union (C. Berti, Z.M. Lifton, R. Di Fiori).

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

Member, Association of American State Geologists (C. Berti).

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

Member, Eastern Snake Hydrologic Modeling Committee (A.L. Clark).

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

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

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

Member, Idaho Association of Professional Geologists (M.D. Barton, A.L. Clark, Z.M. Lifton).

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

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

Member, IRIS PASSCAL (C. Berti).

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, Western States Seismic Policy Council (Z.M. Lifton).

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

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

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

Participant, 9th Annual Energy Policy Research Conference and Geothermal Field Trip, Boise State University, Boise, September-October 2019 (A.L. Clark).

Participant, American Exploration and Mining Association Annual Meeting, Reno, Nevada, December 2019 (V.S. Gillerman).

Participant, American Geophysical Union Geoscience Congressional Visit Day, Washington, D.C., September 2019 (Z.M. Lifton).

Participant, Association of American State Geologists Annual Meeting, Virtual Meeting, June 2020 (C. Berti).

Participant, Association of American State Geologists Spring Liaison, Washington, D.C., February 2020 (C. Berti).

Participant, Boise Section of Society for Mining, Metallurgy, and Exploration Meetings, Boise, September and November 2019, January and March 2020 (V.S. Gillerman).

Participant, Collaborative Database Effort for Geology Monthly Meetings, Virtual Meetings, July 2019-June 2020 (L. Tedrow).

Participant, Digital Mapping Techniques Workshop, Virtual Workshop, June 2020 (C. Berti, L. Tedrow).

Participant, Geological Society of America Annual Meeting, Phoenix, Arizona, September 2019 (V.S. Gillerman).

Participant, Geothermal energy in Idaho meeting with Senator Risch staff, Boise, January 2020 (C. Berti, A.L. Clark).

Participant, Idaho Department of Lands, Idaho Governor's Office of Energy and Mineral Resources, and Idaho Water Resources Department regarding Mountain Home geothermal resource, Boise, February 2020 (A.L. Clark).

Participant, Idaho Environmental Forum, Boise, February 2020 (V.S. Gillerman).

Participant, Idaho Fall Water Supply Outlook Meeting, Boise, November 2019 (A.L. Clark).

Participant, Idaho Fall Water Supply Outlook Meeting, Boise, January 2020 (A.L. Clark).

Participant, Idaho Mining Association Conference, Boise, October 2019 (C. Berti, V.S. Gillerman, R.S. Lewis).

Participant, Idaho Office of Emergency Management meeting regarding irrigation canal encroachment video and public service announcement, Boise, January 2020 (A.L. Clark).

Participant, Idaho Oil and Gas Commission Meeting, Boise, August 2019, September 2019, February 2020, May 2020 (M.D. Barton).

Participant, Mine Safety and Health Administration (MSHA) Training, Boise, December 2019 (V.S. Gillerman).

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

Participant, Python Lidar Point Cloud Processing Workshop, Potsdam, Germany, September 2019 (Z.M. Lifton).

Participant, U.S. Geological Survey Earth MRI Critical Minerals Workshop, Fort Collins, Colorado, September 2019 (V.S. Gillerman, R.S. Lewis).

Participant, U.S. Geological Survey Grant Review Panel (Z.M. Lifton).

Participant, U.S. Geological Survey Statemap Grant Review Panel, Socorro, New Mexico, February 2020 (C. Berti).

Representative, UNAVCO WinSAR Consortium (Z.M. Lifton).

Reviewer, Midas Gold manuscript for Geological Society of Nevada proceedings (V.S. Gillerman).

Reviewer, Mountain Home Air Force Base Environmental Assessment for Geothermal Energy Development (A.L. Clark).

Reviewer, Utah Geological Survey publication manuscript (V.S. Gillerman).

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

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

Grants and Contracts

Aftershock deployment for Stanley, ID earthquake 2020: C. Berti (IRIS PASSCAL, April 2020-November 2020, instrumentation grant).

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

Data Preservation 12: R.S. Lewis and V.S. Gillerman (U.S. Geological Survey, July 2019-July 2020, \$67,496).

Detailed Mapping of the Holocene- and Late Quaternary-Active Traces of Northern Utah/Southern Idaho Active faults: Collaborative Research with Idaho Geological Survey and Utah Geological Survey: Zach Lifton (U.S. Geological Survey NEHRP Earthquake Hazard Program, July 2019-Dec 2020, \$28,218.56).

Development of a Statewide Landslide Inventory Database: Zach Lifton (ITD Research Grant, October 2018-October 2020, \$90,114).

Geologic Mapping in the Idaho cobalt belt: R.S. Lewis (U.S. Geological Survey, August 2019-July 2021, \$100,000).

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-August 2020, \$164,417).

Geologic Mapping in the Preston, Weiser, Salmon, and Elk City areas and supplemental funding for Weiser, Salmon, and Rexburg databases: R.S. Lewis and D.M. Feeney (U.S. Geological Survey Statemap Program, June 2020-May 2021, \$318,392).

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 2020, \$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 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 (FEMA Cooperative Technical Partner Grant, September 2018-September 2019, \$6,247).

Raft River Valley Hydrogeologic Investigation Phase 1: A.L. Clark (Idaho Department of Water Resources, December 2019-November 2020, \$107,500).