On the Cover

Oblique aerial photograph of a rockfall on U.S. Highway 95 south of Riggins near milepost 188. The initial rockfall occurred July 3, 2020, followed by subsequent slope failures. Mitigation included scaling and blasting to stabilize this slope.

Fiscal Year 2021
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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 the 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 geosciences and emphasizes the practical application of geology to benefit society. The Survey seeks to accomplish its responsibilities through research, service, education, and outreach.

FY 2021 By the Numbers

- Collaborating partners: 89
- Active awards: 16
- Funding partners: 7
- Publications: 18
- Professional presentations: 18
- Educational presentations: 7
- Web products: 3
- Reports: 14
- Media interviews: 21
From the Director

It is with pride that I present you the IGS Annual Report for Fiscal Year (FY) 2021. It has been a challenging year on many fronts worldwide, yet I can confidently say that the Survey was able to weather the situation, perform superlatively, and exceed all expectations.

In a year of budget cuts and restrictions mandated by the exceptional circumstances of the ongoing pandemic, a conservative financial approach has allowed the Survey to complete its mandate, and a very successful extramural funding effort has guaranteed a large presence in the field and the acquisition of new scientific instrumentation.

Many staff members worked remotely for most of the year, adapting to a “new normal” quickly and efficiently. We discovered new meanings and uses for “porch sitting” and turned backyards into open-air workspaces. Everyone rose to the occasion and generously contributed to the success of the agency.

IGS onboarded four new staff members who bring new expertise and perspectives to the already diverse pool of technical skills. Dr. Nathan Hopkins is the new Manager of the Digital Mapping and GIS Lab, a core function of the Survey. Ben Bailey is a new addition to the lab as a GIS Analyst. Dr. Jess Starnes joined as Data Preservation Specialist and will assist the ever-growing effort of data preservation. Mary Tkach is the new Junior Geologist, assisting senior staff in the recent and expanding effort in critical minerals research. We are all working hard to guarantee that all grant-funded positions can extend long into the future in the service of the state.

The year has also been characterized by excellent scientific progress: new maps have been completed, the statewide landslide inventory has been completed and published, and progress has been made in the active fault database. Hydrogeologic studies in key basins have progressed, and results are in the final phase of publication. New collaborations with neighboring states have been established on geothermal studies. In the field of critical minerals, IGS has made a tremendous effort both in research and in serving as a regional coordinator for several initiatives from the U.S. Geological Survey (USGS). Much progress has been made in several other fields, as you will learn throughout the report. Our collaboration with industry partners, sister agencies, and local stakeholders has proven beneficial for all parties involved. IGS has a new website, which we designed to address customer needs, improve searchability, and facilitate access to the wealth of data that the Survey produces and collects.

Thank you for taking the time to browse through the following pages. I hope you will enjoy learning about the exciting progress and the many accomplishments of the IGS, as well as the many future opportunities for better serving Idaho’s constituents.

Claudio Berti
Director and State Geologist
ORGANIZATION AND PERSONNEL

Organization Chart

Governor

State Board of Education

President, University of Idaho

Vice President for Research and Economic Development

Director and State Geologist

Claudio Berti

Digital Mapping Manager
Nathan Hopkins

Finance and Operations Manager
John Brabb

Management Assistant
Kristen Pekas

Research Geologist
Reed Lewis

Senior Geologist
Dennis Feeney

Senior Geologist
Russell Di Fiori

Research Geologist
Virginia Gillerman

Hydrogeologist
Alexis Clark

Senior Petroleum Geologist
Mark Barton

Hazards Geologist
Zach Lifton

Junior Geologist
Mary Tkach

Digital Cartographer
Jonathan Sandquist

GIS Analyst
Linda Tedrow

GIS Analyst
Benjamin Bailey

Database Manager, Mines and Prospects
Christopher Tate

IH Geologist
Russell Burmester

IH Geologist
David Stewart

IH Geologist
Keegan Schmidt

IH Research
Harrison Huttanus

IH Research
Megan Ellis

IH Research
Garrett Stephens

Editor
D. Kate Schalck

Data Preservation Specialist
Jesslyn Starnes

Temporary help and/or soft money positions
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
                                     Interim Digital Mapping and GIS Lab Manager, Moscow (July 2020-January 2021)
John R. Brabb ........................................ Finance and Operations Manager, Moscow
Nathan Hopkins* ................................. Digital Mapping and GIS Lab Manager (January 2021-present)
Kristen Pekas ........................................ Management Assistant, Moscow

Research, Full-Time
Benjamin Bailey* .................................... GIS Analyst, Moscow
Mark Barton ............................................ Senior Petroleum Geologist, Boise
Alexis Clark ............................................. Hydrogeologist, Boise
Russell 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
Jesslyn Starnes* ...................................... Data Preservation Specialist, Moscow
Christopher A. Tate ................................. Mines and Prospects Database Manager, Moscow
Linda Tedrow ......................................... GIS Analyst, Moscow
Mary Tkach* .......................................... Junior Geologist, Moscow

Research and Support, Part-Time
Russell F. Burmester ................................. Geologist
Andrew Canada ....................................... Geologist
James C. Coogan ..................................... Geologist
Skye W. Cooley ...................................... Geologist
Scott Ducar ............................................ Research Support
Harrison Huttanu .................................... Research Support
Siara Prpich .......................................... Work Study
Wes Sandlin ............................................ Research Support
D. Kate Schalck ...................................... Geologic Editor
Keegan L. Schmidt .................................. Geologist
William Schuster .................................... Research Support
Garrett Stephens ...................................... Research Support
David E. Stewart ..................................... Research Support

*New hire in FY 2021.
Idaho Geological Survey Advisory Board

Ex Officio: Claudio Berti – Chair  
Director and State Geologist  
Idaho Geological Survey

Leslie Baker  
Chair  
Department of Geological Sciences  
University of Idaho  
(July 2019-October 2020)

Susan Cleverly  
Mitigation Section Chief  
Idaho Office of Emergency Management

Benjamin Crosby  
Chair  
Department of Geosciences  
Idaho State University

Chris Dail  
Exploration Manager  
Perpetua Resources Idaho, Inc  
(formerly Midas Gold Idaho, Inc.)

Jerry Fairley  
Chair  
Department of Geography and Geology  
University of Idaho  
(October 2020-present)

David Hawk  
Representative  
Office of the Governor

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

Rich Reed  
President  
Idaho Association of Professional Geologists
Idaho Geological Mapping Advisory Committee

Dale Kerner – Chair
Permitting Manager
Perpetua Resources Idaho, Inc
(formerly Midas Gold Idaho, Inc.)

Dominique Brough
Geologist
Caribou-Targhee National Forests

John Chatburn
Administrator
Idaho Office of Energy and Mineral Resources

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

Mike McVay
Hydrogeologist
Idaho Department of Water Resources

Jonathan Moore
Project Geologist
Hecla Silver Valley, Inc.

Shawn Nield
State Soil Scientist
Natural Resources Conservation Services

David Pearson
Associate 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

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

FY 2021 Budget Table

<table>
<thead>
<tr>
<th>Category</th>
<th>Beginning Balance</th>
<th>Income or Appropriations</th>
<th>Expenses</th>
<th>Ending Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>$1,094,500.00</td>
<td>$801,703.20</td>
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<td></td>
</tr>
<tr>
<td>Operating Expense</td>
<td>$10,700.00</td>
<td>$83,453.30</td>
<td></td>
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</tr>
<tr>
<td>Capital Outlay</td>
<td>$</td>
<td>$164,743.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Appropriations</td>
<td>$1,105,200.00</td>
<td>$1,049,900.00</td>
<td>$55,300.00</td>
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<tr>
<td>UI Personnel Funds (Furlough Reduction)</td>
<td>$ (55,300.00)</td>
<td>(55,300.00)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Service</td>
<td>$49,073.71</td>
<td>$9,778.01</td>
<td>$82,508.49</td>
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</tr>
<tr>
<td>Service Center</td>
<td>$40,249.88</td>
<td>$28,841.17</td>
<td>$40,936.52</td>
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<tr>
<td>Restricted Gifts</td>
<td>$7,367.62</td>
<td>-</td>
<td>$7,367.62</td>
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<tr>
<td>Sponsored Programs</td>
<td>$828,274.39</td>
<td>$715,253.53</td>
<td>$790,444.86</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>$924,965.60</td>
<td>$1,803,772.71</td>
<td>$976,557.49</td>
<td></td>
</tr>
</tbody>
</table>

Trends in Expenditures

FY 2022 Budget Request

The FY 2022 budget request included no line items in accordance with the Governor’s Office directives. IGS was allocated $1,094,500 in personnel costs with additions of $4,200 in changes for benefit costs and a $18,900 (2%) change in employee compensation bringing the personnel allocation to $1,117,600. The Other Expense (OE) allocation remained at $10,700 for a total budget of $1,128,300. Approximately 40% of the awarded salary and associated benefits increase are projected to be generated by grant-funded salary and benefit savings.
Sources of Funding

<table>
<thead>
<tr>
<th>Source of Funding</th>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Grants and Contracts</td>
<td>$370,463.94</td>
<td>(20%)</td>
</tr>
<tr>
<td>State Grants and Contracts</td>
<td>$276,493.97</td>
<td>(15%)</td>
</tr>
<tr>
<td>Industry Grants and Contracts</td>
<td>$68,295.62</td>
<td>(4%)</td>
</tr>
<tr>
<td>Service Center</td>
<td>$9,778.01</td>
<td>(1%)</td>
</tr>
<tr>
<td>State Appropriations</td>
<td>$28,841.17</td>
<td>(58%)</td>
</tr>
</tbody>
</table>

Since its release in 2012, *Geologic Map of Idaho* (M-9) has continued to be the best-selling IGS publication. Nearly all publications are available for free download on the IGS website.

Publication Sales

<table>
<thead>
<tr>
<th>Year</th>
<th>TOTAL SALES</th>
<th>IGS Publications</th>
<th>IGS Geologic Maps</th>
<th>Topographic Maps</th>
<th>Other Maps</th>
<th>Books</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2016</td>
<td>$10,158</td>
<td>$4,362</td>
<td>$2,585</td>
<td>$2,644</td>
<td>$504</td>
<td>$63</td>
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<tr>
<td>FY 2017</td>
<td>$7,564</td>
<td>$2,840</td>
<td>$2,227</td>
<td>$2,203</td>
<td>$294</td>
<td>$0</td>
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<tr>
<td>FY 2018</td>
<td>$7,261</td>
<td>$2,176</td>
<td>$3,000</td>
<td>$1,811</td>
<td>$270</td>
<td>$4</td>
</tr>
<tr>
<td>FY 2019</td>
<td>$9,678</td>
<td>$3,569</td>
<td>$3,811</td>
<td>$1,978</td>
<td>$295</td>
<td>$25</td>
</tr>
<tr>
<td>FY 2020</td>
<td>$8,117</td>
<td>$4,140</td>
<td>$2,352</td>
<td>$1,458</td>
<td>$167</td>
<td>$0</td>
</tr>
<tr>
<td>FY 2021</td>
<td>$4,321</td>
<td>$2,311</td>
<td>$1,240</td>
<td>$659</td>
<td>$111</td>
<td>$0</td>
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</table>
# PARTNERSHIPS

## Funding Partners

<table>
<thead>
<tr>
<th>Funding Partner</th>
<th>Project/Mapping</th>
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<tbody>
<tr>
<td>Idaho Department of Lands</td>
<td>Abandoned Mine Lands Project</td>
</tr>
<tr>
<td>Idaho Department of Water Resources</td>
<td>Big Lost River Valley; Raft River Valley</td>
</tr>
<tr>
<td>Idaho Transportation Department</td>
<td>Landslide Inventory Database</td>
</tr>
<tr>
<td>Idaho Office of Emergency Management</td>
<td>Fault Database</td>
</tr>
<tr>
<td>Integra Resources</td>
<td>De Lamar and Swisher Mountain mapping</td>
</tr>
<tr>
<td>U.S. Geological Survey</td>
<td>STATEMAP, Data Preservation, NEHRP, Earth MRI</td>
</tr>
<tr>
<td>Wilmat Petroleum Company</td>
<td>Yellow Pine mapping</td>
</tr>
</tbody>
</table>
## Collaborators

<table>
<thead>
<tr>
<th>American Exploration and Mining Association</th>
<th>Incorporated Research Institutions for Seismology Portables Array Seismic Studies of the Continental Lithosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Geophysical Union</td>
<td>Lehigh University</td>
</tr>
<tr>
<td>American Geosciences Institute</td>
<td>Letts Consultants International</td>
</tr>
<tr>
<td>American Water Resources Association, Idaho State Section</td>
<td>Lewis-Clark State College</td>
</tr>
<tr>
<td>Association of American State Geologists</td>
<td>Perpetua Resources Idaho, Inc. (formerly Midas Gold Idaho, Inc.)</td>
</tr>
<tr>
<td>Belt Association</td>
<td>Missouri State University</td>
</tr>
<tr>
<td>BGC Engineering</td>
<td>Montana Bureau of Mines and Geology</td>
</tr>
<tr>
<td>Boise State University</td>
<td>Nanometrics</td>
</tr>
<tr>
<td>Brigham Young University-Idaho</td>
<td>National Academy of Sciences</td>
</tr>
<tr>
<td>Center for Advanced Energy Studies</td>
<td>Nevada Bureau of Mines and Geology</td>
</tr>
<tr>
<td>Centro Nacional de Investigación sobre la Evolución Humana</td>
<td>New Jersey Mining Company</td>
</tr>
<tr>
<td>College of Idaho</td>
<td>Northwest Knowledge Network</td>
</tr>
<tr>
<td>College of Western Idaho</td>
<td>Oregon Department of Geology and Mineral Industries</td>
</tr>
<tr>
<td>Earthquake Engineering Research Institute</td>
<td>Orma J. Smith Museum of Natural History</td>
</tr>
<tr>
<td>Eastern Washington University</td>
<td>Owyhee Gem and Mineral Society</td>
</tr>
<tr>
<td>Federal Emergency Management Agency</td>
<td>Revival Gold</td>
</tr>
<tr>
<td>First Cobalt</td>
<td>Snake River Oil and Gas</td>
</tr>
<tr>
<td>Franklin and Marshall College</td>
<td>Schlumberger Petroleum Services</td>
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<tr>
<td>Frontier Precision</td>
<td>Society of Mining Engineers, Boise Section</td>
</tr>
<tr>
<td>Geological Society of America</td>
<td>Spokane Community College</td>
</tr>
<tr>
<td>GeoMark Research</td>
<td>Tobacco Root Geological Society</td>
</tr>
<tr>
<td>GeoSep Services</td>
<td>U.S. Bureau of Land Management</td>
</tr>
<tr>
<td>Governor’s Office, State of Idaho</td>
<td>U.S. Bureau of Reclamation</td>
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<tr>
<td>Hecla Mining Company</td>
<td>U.S.D.A. Agriculture Research Service</td>
</tr>
<tr>
<td>Hells Canyon Gem Club</td>
<td>U.S. Forest Service</td>
</tr>
<tr>
<td>Horse Heaven Syndicate</td>
<td>U.S. Geological Survey—Minerals Program</td>
</tr>
<tr>
<td>Ice Age Floods Institute</td>
<td>U.S. Geological Survey—NEHRP</td>
</tr>
<tr>
<td>Idaho Department of Environmental Quality</td>
<td>U.S. Geological Survey—Water Resources Division</td>
</tr>
<tr>
<td>Idaho Department of Lands</td>
<td>U.S. Geological Survey—Data Preservation</td>
</tr>
<tr>
<td>Idaho Department of Water Resources</td>
<td>U.S. Geological Survey—Earth MRI Program</td>
</tr>
<tr>
<td>Idaho Governor’s Office of Energy and Mineral Resources</td>
<td>U.S. Geological Survey—NCGMP</td>
</tr>
<tr>
<td>Idaho Ground Water Monitoring Technical Committee</td>
<td>University of Alaska, Fairbanks</td>
</tr>
<tr>
<td>Idaho Historical Society</td>
<td>University of Idaho</td>
</tr>
<tr>
<td>Idaho Mining Association</td>
<td>University of Massachusetts, Lowell</td>
</tr>
<tr>
<td>Idaho Museum of Mining and Geology</td>
<td>University of Montana</td>
</tr>
<tr>
<td>Idaho Office of Emergency Management</td>
<td>University of Nevada, Las Vegas</td>
</tr>
<tr>
<td>Idaho Oil and Gas Conservation Commission</td>
<td>University of Potsdam</td>
</tr>
<tr>
<td>Idaho Public Television</td>
<td>Utah Geological Survey</td>
</tr>
<tr>
<td>Idaho State University</td>
<td>Washington Geological Survey</td>
</tr>
<tr>
<td>Idaho Transportation Department</td>
<td>Washington State University</td>
</tr>
<tr>
<td>Indiana State University</td>
<td>Western Colorado University</td>
</tr>
<tr>
<td>Integra Resources</td>
<td>Western States Seismic Policy Council</td>
</tr>
<tr>
<td>Intermountain Forestry Cooperative</td>
<td>Wyoming Geological Survey</td>
</tr>
<tr>
<td>Instrumental Software Technology, Inc.</td>
<td>Yellowstone Volcano Observatory</td>
</tr>
</tbody>
</table>
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. 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 such as defining groundwater resources, identifying and categorizing geological materials for engineering needs, aiding in infrastructure, identifying seismic and landslide hazards, assisting with timber management, and providing geologic data for potential mineral and aggregate resources on public lands. The largest source of funding for Idaho’s geologic mapping program is provided by the STATEMAP component of the USGS National Cooperative Geologic Mapping Program (NCGMP). The Idaho Geological Mapping Advisory Committee helps the IGS determine Idaho’s geologic mapping needs and develop long-term planning for geologic mapping.
A) LiDAR-derived imagery from the Elk City 7.5′ quadrangle highlighting a young to recent normal fault scarp, and B) 1:24,000-scale geologic map of the same area.

In FY 2021:

- New mapping was conducted in the Elk City, Preston, and Salmon project areas, where Survey geologists mapped six 7.5′ quadrangles (Harpster, Orogrande, Elk City, Henderson Ridge, Boundary Ridge, and Pegram Creek).

- New maps were published for the Yellow Pine 7.5′ quadrangle, Sandpoint 30′ x 60′ quadrangle, and 1:24,000-scale maps of the Burke, Murray, Osburn, Bayhorse, Clayton, and Leadore areas.
**Research Spotlight: Earth MRI**

To reduce the country's dependance on foreign-sourced minerals that are fundamental to our security and economy, the USGS developed the Earth Mapping Resources Initiative (Earth MRI). The IGS continued work on a two-year Earth MRI mapping project funded in FY 2020 in the Idaho cobalt belt near Salmon. Both cobalt and rare-earth elements (REEs) are the focus of this effort. Field work in the Degan Mountain, Taylor Mountain, and Cobalt quadrangles was finished, and a detailed compilation of the geology in the Blackbird mine area was nearing completion.

**Hydrogeology**

During FY 2021 the hydrogeology program supported the IGS mission through research, collaboration with other agencies, and communication with the public on groundwater supply resources and groundwater quality topics for Idaho.

In FY 2021:

- IGS completed Phase 1 of the Raft River Basin Hydrogeology Study (See Research Spotlight).

- IGS started Phase 2 of the Raft River Basin Hydrogeology Study (See Research Spotlight).

- IGS continued preparation of groundwater budgets spanning 2000-2019 at a watershed scale for the Big Lost River Basin in south-central Idaho. The project is part of a larger study conducted during 2018-2021 in collaboration with Idaho Department of Water Resources (IDWR) and the USGS with Department of Energy Supplemental Environmental Project funding. Publication of the groundwater budget results as a separate chapter in a USGS scientific investigation report is scheduled for Spring 2022.
Research Spotlight: Raft River Basin Hydrogeology Study

In November 2020 IGS completed a one-year hydrogeology study (Phase 1) of the Raft River Basin in southern Idaho with IDWR, funded by the Idaho Water Resources Board (IWRB). Project objectives were to address declining groundwater level trends in the basin. This first project phase included compilation of existing hydrogeologic datasets, field reconnaissance in support of future data collection, and identification of perceived data gaps with recommendations for future investigations. IGS supported siting of 12 new monitoring wells, scheduled for installation by IDWR in Spring 2022, to be incorporated into IDWR’s existing monitoring well network. In 2020 the USGS installed two new dedicated streamgage stations (Cassia Creek and Raft River), and IDWR installed stream monitoring equipment in other drainages as part of the investigation. In December 2020 IGS commenced Phase 2 of a three-year hydrogeology study of the Raft River Basin in collaboration with IDWR through an IWRB grant. This project spans 2021-2023 and includes preparation by IGS of a hydrogeologic framework and groundwater budget. IGS publication of the study findings is planned for late fall 2023.

Geologic Hazards

FY 2021 saw significant landslide and earthquake activity within Idaho. Several landslides and rockfall impacted highways, including major events on U.S. Highway 95 near Riggins and State Highway 55 near Smiths Ferry. Aftershocks from the March 31, 2020 Mw6.5 Stanley earthquake continued to shake central Idaho throughout FY 2021. This aftershock activity is normal and expected following an earthquake of this size.
Annual Report | Fiscal Year 2021
Idaho Geological Survey


The geologic hazards program continued studies on existing and potential hazards and disseminating data. In FY 2021:

- New surficial fault mapping, funded by the USGS National Earthquake Hazards Reduction Program (NEHRP), of Bear Lake Valley, Gem Valley, and Blackfoot Volcanic Field was completed. Recent LiDAR data covering southeast Idaho allows for the highest-resolution surface fault trace mapping yet published. The new mapping is being incorporated into the updated fault database.
• The IGS and Boise State University published a peer-reviewed article in *Seismological Research Letters* on the tectonic and geophysical background of the 2020 Mw6.5 Stanley earthquake.
Research Spotlight: Landslide Inventory and Active Faults Databases

One of the primary goals of the geologic hazards program in recent years has been to compile and publish two fundamental datasets: a landslide inventory database and an active faults database. Toward that goal, the Survey has made significant progress in FY 2021. With the help of a two-year research grant from the Idaho Transportation Department, the Survey compiled available landslide mapping and published it as a digital landslide inventory database. The new landslide database contains more than 4,000 records and is available as an interactive webmap and a GIS geodatabase. This is a significant improvement over previous versions of the statewide landslide database and provides users with an important tool for assessing slope stability hazards.

With the help of grants from the Idaho Office of Emergency Management and the USGS Data Preservation program, the Survey is also currently working on updating and revising the statewide active faults database. This database contains mapping of surface fault traces and fault source parameters for known or suspected active faults. A new database with a modern interactive webmap interface was built to house the fault data and new mapping is being completed as LiDAR becomes available. In addition, the Survey digitized hundreds of hardcopy reports referenced in the database.
Mines and Minerals

Idaho’s mining was alive and well in FY 2021. The IGS continued to research and report on Idaho’s mineral industry. Two IGS Staff Reports (S-21-01 and S-21-02) with annual descriptions for 2014-2017 were released. Active mining and exploration activity in FY 2021 included:

• Hecla’s Lucky Friday mine in the Silver Valley returning to full production in November after a long strike.
• Exploration drills turning at the Galena mine of Americas Gold and Silver Corporation.
• New work being done at the Bunker Hill mine.
• New Jersey continuing to mine gold at Murray.
• Three large phosphate plants and mines operating in Caribou County.
• The largest exploration projects, all for gold and silver, operated by Integra Resources at De Lamar, Revival Gold at Beartrack and Arnett Creek, and Liberty Gold at Black Pine; in each case deeper, higher-grade mineralization being explored below open pit mines which closed around 2000.
• Two projects in the Idaho cobalt belt continuing, and precious metal rich polymetallics also being targeted.
Research Spotlight: De Lamar and Swisher Mountain Quadrangles Mapping Project

Integra Resources Corporation funded a two-year, regional-style geologic mapping study of two 1:24,000 scale quadrangles in Owyhee County, surrounding their project on the De Lamar and Florida Mountain mine sites. Mapping of the De Lamar and adjacent Swisher Mountain 7.5’ quadrangles was completed at the end of FY 2021. Work focused on refining the Mid-Miocene stratigraphy of the volcanic rocks and distinguishing the multiple rhyolite domes, mapping multiple ages of faults, seeking controls on alteration and mineralization, and understanding the geologic history of the region. The Silver City district produced approximately 1.3 million troy ounces of gold and over 72 million troy ounces of silver from three epithermal mineralized centers (De Lamar, Florida Mountain, and War Eagle) discovered in the 1860s. Mining ceased in 1998, and Integra is currently drilling the Florida Mountain deposit to define additional resources.

The map includes 37 XRF whole-rock chemical analyses of the volcanic units and eight new U-Pb ID-TIMS age determinations on zircons from the silicic units, analyzed by Boise State University. Petrographic descriptions and the new ages document three groups of Miocene-age silicic magmatism. The oldest group includes the quartz-sanidine rhyolite domes which host mineralization (R1 and later R2) and range from 16.398 ± 0.007 Ma to 16.176 ± 0.008 Ma (5 samples); the next group is the overlying plagioclase rhyolites with one unit dated at 15.722 ± 0.011 Ma and the post-mineral Millsite rhyolite at De Lamar at 15.706 ± 0.007 Ma; and the third group is the unaltered, voluminous Swisher Mountain Rhyolite dated at 14.746 ± 0.008 Ma. Mineralization at De Lamar is bracketed in age between groups 1 and 2. Much of the faulting and basin development in the western part of the map area is interpreted to have occurred after or during eruption of the group 2 volcanic units and prior to emplacement of the Swisher Mountain Rhyolite.
Energy

Geothermal Energy

Information on Idaho’s geothermal exploration and development status was published in FY 2021 for 2015-14 and 2016-17, respectively as staff reports S-21-01 and S-21-02. These reports also summarize Idaho’s activities related to mining and oil and gas.

Research Spotlight: INGENIOUS

IGS is part of a geothermal energy research team working on an initiative funded by U.S. Department of Energy to promote advancement of emerging and innovative, commercially viable geothermal energy technologies. Goals of the Innovative Geothermal Exploration through Novel Investigations of Undiscovered Systems (INGENIOUS) geothermal project are to reduce costs and risks associated with geothermal energy development. The Great Basin Center for Geothermal Energy, within the Nevada Bureau of Mines and Geology, is the project lead. This 4.5-year project focuses on exploration research and development of hydrothermal and low temperature resources in hidden geothermal systems in the Basin and Range province, including areas in Idaho, Nevada, and Utah. Under the Geothermal Technologies Office Play Fairway Analysis (PFA) initiative, the project anticipates drilling at five sites and conducting geophysical surveys. Analyses will incorporate PFA, machine learning, and advanced geostatistical approaches. The PFA technique, adapted from the oil and gas industry, uses statistical methods to create a risk-based ranking for better understanding the occurrence and distribution of heat flow. During FY 2021 IGS assisted the compilation and synthesis of Idaho datasets for preparation of a regional map.

Oil and Gas

During FY 2021 the oil and gas program advanced the understanding of petroleum resources in Idaho by:

- Conducting primary research on the formation and occurrence of proven and possible petroleum systems.
- Providing new information that highlights the exploration potential of frontier and underexplored 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, policymakers, and the public.
Recent work at the IGS integrating seismic and well data from the Western Snake River Plain (WSRP) illustrates the stratigraphic and structural configuration of known hydrocarbon accumulations beneath the WSRP and their relationship to presumed source rocks. Within the deeper portion of the basin, conventional accumulations of wet gas,
condensate, and light oil have been discovered from sandstones units (Harmon and Willow) associated with the syn-rift succession. The Willow Sandstone represents a high-net fluvial sandstone body that extends across several half-graben structures. The Harmon Sandstone represents a mix of fluvial sandstones and overbank mudstones deposited during the last phase of graben formation. A variety of potential trapping structures exist including faulted anticlines, tilted fault blocks, and stratigraphic pinch-outs. Lacustrine mudstones that directly overlie the syn-rift succession act as a high-quality regional seal. Within the shallow section, lean gas to wet gas is commonly encountered in the shallow, toe-of-slope sandstones of the upper sag sequence. Potential trapping structures include folds and faults associated flower structures.

Geochemical data from produced fluids and gases suggests hydrocarbons in the deeper syn-rift reservoirs were generated from sediments rich in terrestrially derived organic matter as they were heated and buried to depths of 5,000-8,000 ft. Candidate source rocks for the hydrocarbons are paludal and near-shore lacustrine sediments that comprise the pre-rift and initial syn-rift successions. Hydrocarbons from the upper Sag sequence are made up of variable mixtures of shallow biogenic gas and thermogenic gas produced at depth.
Instrumentation

In FY 2021 IGS acquired new instrumentation and software in an effort to initiate filling a historic gap in data collection. The lack of instrumentation has affected the ability to collect data critical for hazard mitigation, among many other important applications, and IGS intends to increase its instrumental capabilities in the years to come. In FY 2021 the acquisition of new instruments was possible thanks to a conservative approach in IGS finances combined with savings related to travel and operations restrictions due to COVID-19. IGS acquired:

Seismometers

- 4 broadband seismometers and digitizer (Nanometrics Trillium Compact Horizon and Nanometrics Centaur)
- 1 broadband and strong motion seismometer and digitizer (Nanometrics Trillium Cascadia and Nanometrics Centaur)
- 1 quick deployment broadband seismometer kit (Nanometrics Trillium Compact Horizon and Nanometrics Pegasus)
- The seismic monitoring instruments will add to the pool of 6 GEObit S-100 wide band seismometers and GEObit GEOthree digitizers purchased at the end of FY 2020.

Passive seismic stratigraphy and Vs30/VsH soil characterization

- 1 MoHo Tromino

Magnetic susceptibility meters

- 2 Terraplus KT-10 v2 PLUS

Differential RTK GPS units

- 1 Trimble R8s Rover
- 1 Trimble R9s Base
- 1 Trimble Zephyr 3 GPS antenna
- 1 Trimble TSC5 data collector
- 1 Trimble Business Center software

Digital geologic mapping, structural geology, and 3D modelling software

- 1 license of Petroleum Expert MOVE Core
DATA PRESERVATION

Archiving, digitizing, and disseminating our state’s historical geological data is an essential service provided by the IGS, and our data preservation products are second only to IGS publications for public interest and downloads. Our data preservation effort was formally organized in 2007 with funding from the USGS National Geologic and Geophysical Data Preservation Program (NGGDPP) and has expanded with funding from the Idaho Department of Lands in 2009. This work has resulted in thousands of physical documents and other media being digitized and made accessible to the public. In FY 2021:

- The Mines and Prospects database (Mines) underwent operational improvements as well as continued efforts to expand content and improve accuracy. A new version was published in the IGS Digital Database series (DD-1). Functionality was added and improved for filtering Mines webmap searches by the presence of placers, drilling, underground workings, on-site ore processing facilities, and surface or pit mining.

- Sixty-five new references were added to the database, and 267 existing references were reviewed improving location and attributes for up to 4,891 distinct properties and resulting in the addition of 332 new properties with associated location, attribute data, and metadata added to Mines.

- Forty-three new Abandoned Mine Land videos were digitized, adding five additional hours of audio-visual footage to our collection. Currently there are 139 geolocated video clips discoverable and available for download via the Mines webmap and for streaming through the IGS YouTube channel.

- Digitization of the Sandpoint 1° x 2° quadrangle mineral property files was completed, resulting in the availability of 1,232 files for the quad within our database.
• Eight additional Idaho State Annual Mine Inspector Reports (1900-1909) were digitized and posted on the IGS Current and Historic Mining Activity webpage, with two years (1901-1902) data-mined for incorporation into the Mines database.

• Two Regional Development years (1989-1990) were data-mined and incorporated into the Mines database.

• Sixteen well logs for Idaho oil and gas wells were converted from wireline log data to the more versatile LAS industry-standard format.

• Ninety-six unpublished or difficult to locate references concerning Idaho faults were scanned and cataloged.

• Support was provided for the Earth MRI national critical minerals resources inventory.

Data Preservation Spotlight: The “Buckhorn Bob” Collection

In early 2020 Denice Hogan contacted us about a possible donation of Mineral Property Files after the passing of her uncle, Robert “Buckhorn Bob” Causton. Bob had owned an Idaho mining property that had been in the family since the early 1920s and had accumulated a good deal of records dating between 1966 and 2014.

Denice shipped the first installment of records from Bob’s residence in Hawaii in the spring of 2020. These were organized and scanned during the 2020-2021 NGGDPP grant cycle.

A brief history of the Idaho Buckhorn Mine property, written by Bob, can be found in our Mines webmap (see SA0058_095). The majority of the collection can be browsed and downloaded from Property Number SA0058 beginning with SA0058_053. There are other cultural and historical points of interest. The building and collapse of the Eileen dam intended to provide power to the mine is a notable example. During the digitization process, some records were discovered which related to other mining properties not controlled by Bob and were processed accordingly.
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.

Website

idahogeology.org

In FY 2021 IGS worked with First Step Internet to launch a new website. The website has a new look and feel, and, most importantly, a more powerful search function.

The IGS website is the most important tool for providing the public access to publications and data. Nearly all Survey publications (over 1,000) are available for download at no cost. IGS also offers interactive webmaps to search, locate, and download documents and data.

With the launch of our new website, IGS started collecting web stats on April 29, 2021. The number of website viewers was 21,388, and the number of website products used or downloaded was 5,621. Extrapolated over the entire fiscal year, the number of website viewers would exceed 120,000, and the number of website products used or downloaded would approach 32,000.
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.

Digital Mapping and GIS Laboratory

In FY 2021 the Digital Mapping and GIS lab:

• Supported six new mapping projects encompassing eight 7.5’ quadrangles. Projects funded through the STATEMAP program will be submitted in the early months of FY 2022, through an extension of the USGS grant.

• Made progress on backlogged publications. Though the number of publications in FY 2021 remained low, IGS expects a significant increase in publication of Digital Web Maps in the coming year, thanks in large part to the implementation of the USGS Geologic Map Schema (GeMS), which was introduced in 2020.

**Digital Mapping Lab Spotlight: GeMS**

Geologic Map Schema (GeMS) is a geodatabase format for digital geologic maps designed through collaboration between the USGS and state geologic surveys with the objective of digitally encoding the content contained in traditional geologic maps. IGS has embraced this geodatabase standard, participated in technical discussion and interagency working groups, and has made significant progress towards compliance with the schema. IGS expects to fully transition to GeMS for all geologic map production within the coming year. As part of the FY 2021 STATEMAP program, the lab has worked with IGS mapping staff to develop three large map compilations compliant with Level 3 GeMS standards. These compilations include a total of 51 7.5’ quadrangles, many of which are currently unpublished. As part of this effort, IGS plans to publish many of those currently unpublished works.
Earth Science Education

The IGS seeks to promote excellence in the teaching and practice of the earth sciences. In FY 2021 IGS:

- Participated in the American Geosciences Institute sponsored Earth Science Week by distributing fifty Earth Science Week Toolkits to earth science and physical science teachers in southern Idaho and teachers on our mailing list who continually use these kits.

- Celebrated “Geologic Map Day” during Earth Science Week by highlighting the recently published *Geologic Map of the Crane Creek Reservoir Quadrangle, Washington County, Idaho* on the IGS website and social media.

-Partnered with other state and federal agencies in support of “The Great Idaho ShakeOut” on October 15, 2020, a statewide earthquake drill which encourages Idahoans to prepare for major earthquakes.


- Presented educational presentations and participated in outreach events statewide:
  
  *Career paths in Geology Panel Discussion*, Claudio Berti panelist: Lehigh University, November 2020.


  *Mining History of the Boise Foothills and Career Opportunities in Mining Industry*, by Virginia S. Gillerman: Boise State University Geoscience Club, Boise or virtual, October 2020.


PUBLICATIONS AND ACTIVITIES

Publications

Analysis of the Paraglacial Landscape in the Ny-Ålesund Area and Blomstrandøya (Kongsfjorden, Svalbard, Norway), by Ivar Berthling, Claudio Berti, Vania Mancinelli, Laura Stendardi, Tommaso Piacentini, and Enrico Miccadei, Journal of Maps, v.16-2, 2020.


The Blackfoot Volcanic Field of Southeast Idaho—a Result of Interaction Between the Yellowstone Hotspot and Tectonic Activity, by Zach Lifton: Yellowstone Volcano Observatory Caldera Chronicles, 2020.


Abstracts


Reports


Development of a Statewide Landslide Inventory Database for Idaho, by Zachery M. Lifton, Scott D. Ducar, and Christopher Tate: Deliverable to Idaho Transportation Department, December 2020.


Presentations


Web Products


Operational Improvements


Media Interviews


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).

Contributor, USGS National Seismic Hazard Model 2023 Update (Z.M. Lifton).

Federal Aviation Administration Remote Pilot Certificate (Z.M. Lifton).
Fellow, Society of Economic Geologists (V.S. Gillerman).


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

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

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.V. Di Fiori, V.S. Gillerman, N. Hopkins, 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 (A.L. Clark, Z.M. Lifton).

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


Member, Incorporated Research Institutions for Seismology (IRIS) Portable Array Seismic Studies of the Continental Lithosphere (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, Tobacco Root Geological Society (R.V. Di Fiori, R.S. Lewis).

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

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

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


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

Participant, 88th Annual Western Snow Conference: Bridging the Gap between Research and Operations, Virtual Meeting, April 2021 (A.L. Clark).

Participant, American Exploration and Mining Association Convention, Virtual convention, December 2020 (V.S. Gillerman).
Participan, American Geophysical Union Fall Meeting, Virtual conference, December 2020 (R.V. Di Fiori).

Participan, Boise Section of Society for Mining, Metallurgy, and Exploration Meetings, Virtual meetings, September 2020 and February 2021 (V.S. Gillerman).

Participan, Collaborative Database Effort for Geology Monthly Meetings, Virtual Meetings, July 2020-June 2021 (N. Hopkins, L. Tedrow).


Participan, Geological Society of Nevada Meetings, Virtual meetings, October-November 2020 and February-May 2021 (V.S. Gillerman).

Participan, Idaho Mining Association Conference, Virtual conference, October 2020 (R.V. Di Fiori, V.S. Gillerman, R.S. Lewis).


Graduate Thesis Committees

Dana Drinkall, M.S. Geology, Idaho State University (Z.M. Lifton).

John Murphy, M.S. Geology, Washington State University (R.S. Lewis).

Grants and Contracts

Abandoned Mine Lands Project, Task 5: R.S. Lewis (Idaho Department of Lands, March 2019-April 2021, $141,677).

Abandoned Mine Lands Project, Task 6: R.S. Lewis (Idaho Department of Lands, April 2021-March 2023, $169,445).


Development of a Statewide Landslide Inventory Database: Z.M. Lifton (Idaho Transportation Department Research Grant, October 2018-December 2020, $90,114).


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


Update to Idaho’s Active Fault Database: Z.M. Lifton (Idaho Office of Emergency Management, October 2020-July 2021, $40,945.00).