The Discovery of Significant Accumulations of Geologic Hydrogen In Alaska Could Transform Alaska's Energy, Economic, and Environmental Future

Mark Myers, Commissioner USARC

United States Arctic Research Commission 2025 Report

In support of strengthening national security, the U.S. Arctic Research Commission (USARC) has identified research topics within four key sectors:

- Military
- Community
- Energy
- Economy

U.S. ARCTIC RESEARCH COMMISSION

RESEARCH NEEDS FOR A SECURE AND PROSPEROUS ARCTIC

WHY THE ARCTIC MATTERS. The United States is one of only eight Arctic nations. In 1959, Alaska became the 49th State of the Union after being purchased from Russia in 1867. Alaska covers an area that is one-fifth the size of the entire continental United States, and its shoreline is longer than the combined shoreline of all other states. It is home to 733,000 people, 20% of whom are Alaska Native whose ancestors have inhabited the Arctic for thousands of years.

Thanks to its bountiful natural resources, Alaska contributes enormously to the U.S. and global economies. Alaska boasts several of the world's largest and most valuable fisheries (e.g., salmon, pollock, and crab) and has abundant hydrocarbon and mineral resources. The United States recently declared sovereign rights over additional seafloor and subsurface resources in more than a 1.6 million square miles of Alaska's outer continental shelf, which must be assessed for its potential and managed appropriately.

Alaska's strategic geographic location has long been recognized. U.S. Air Force General Billy Mitchell in his 1935 testimony to Congress said, "I believe that in the future, whoever controls Alaska controls the world." For example, Anchorage, Alaska, located fewer than 9.5 hours from 90% of the industrialized world, is currently home to the fourth largest cargo (by volume) airport in the world. Alaska also hosts a significant percentage of our strategic and national air and missile defense capability, including fifth-generation fighter aircraft and a ground-based ballistic missile defense system.

The Arctic is changing in many ways, and quickly. Russia is rapidly expanding its military and economic presence in the Arctic. Non-Arctic nations such as China are showing greater interest in the region, as demonstrated by their icebreaker voyages and joint military operations with Russia in the Arctic Ocean and their continued global quest for resources. Working collaboratively with allies and partners, a deep understanding of the impacts of the rapidly changing Arctic environment globally, as well as at the community level, is required for the United States to maintain an international leadership role in the region.

ABOUT THIS DOCUMENT. Consistent with the President's support of Arctic research, as expressed in the May 2025 *Implementation Plan 2025-2026 for the Arctic Research Plan 2022-2026* published at https://www.whitehouse.gov/wp-content/uploads/2025/03/2025-2026_implementation_plan-artic.pdf, the U.S. Arctic Research Commission provides this document to further advance U.S. Arctic research.

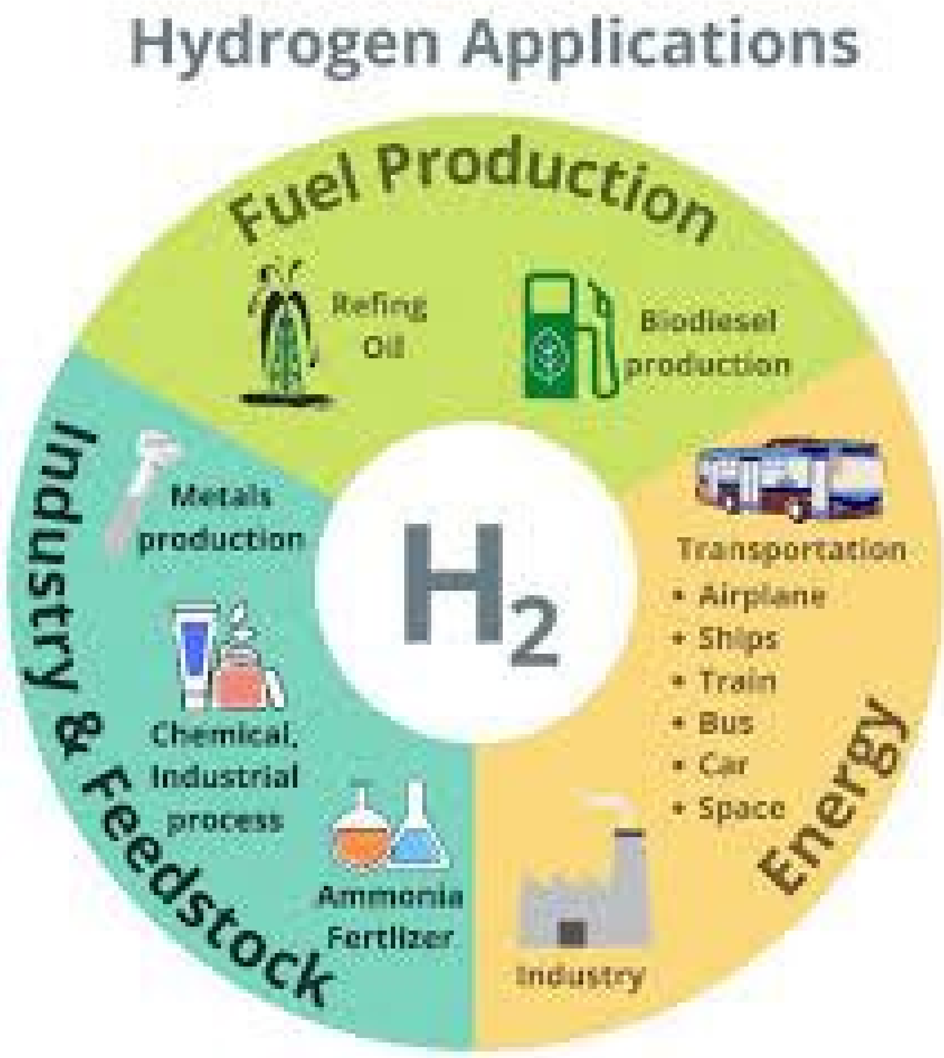
USS Pasadena at ICEX 2022. Image credit: U.S. Navy's Arctic Submarine Laboratory

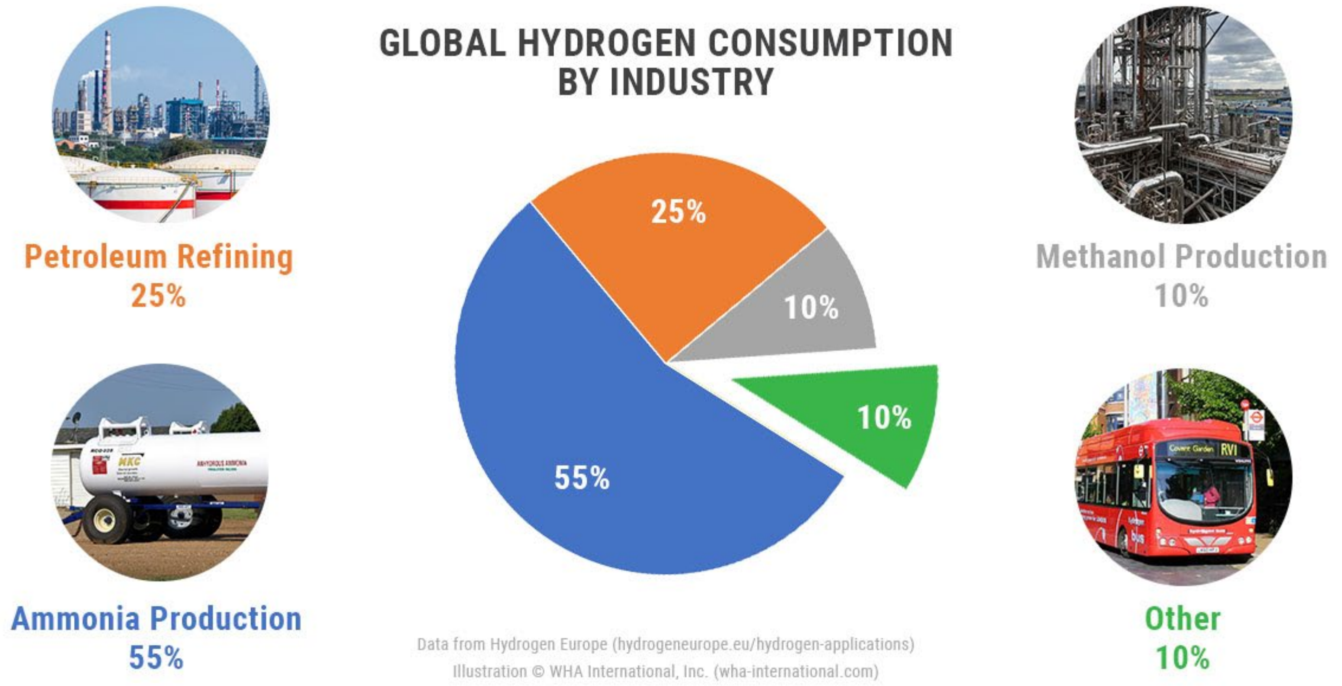
Energy Security

Innovative research is needed on emerging sources and technologies that are well suited
for Alaska

- Geologic hydrogen
- Methane hydrates
- Enhanced geothermal
- Small modular nuclear reactors and microreactors
- Geological sequestration of CO2
- Critical minerals

Current Applications for Hydrogen

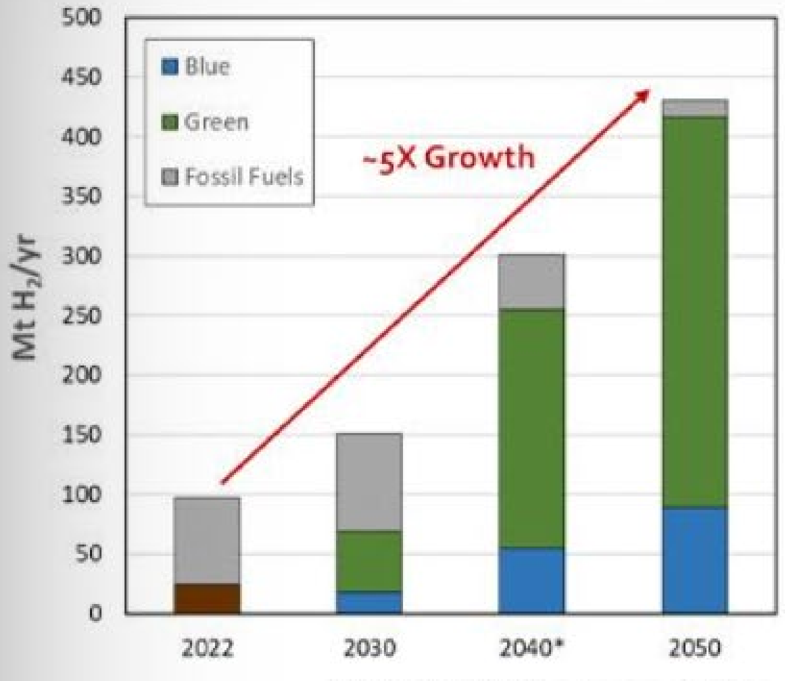




WHA International

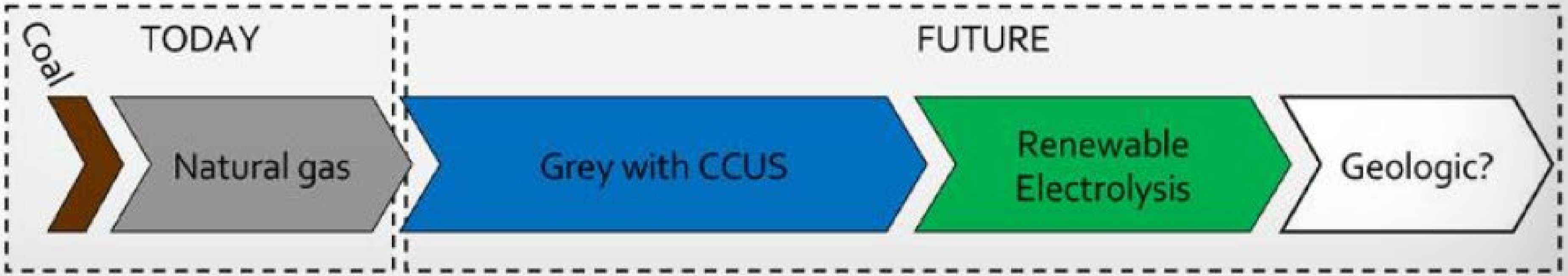
J. Braz. Chem. Soc. 33 (8) • 2022 •
https://doi.org/10.21577/0103-5053.20220026

Global Hydrogen Demand and Sources

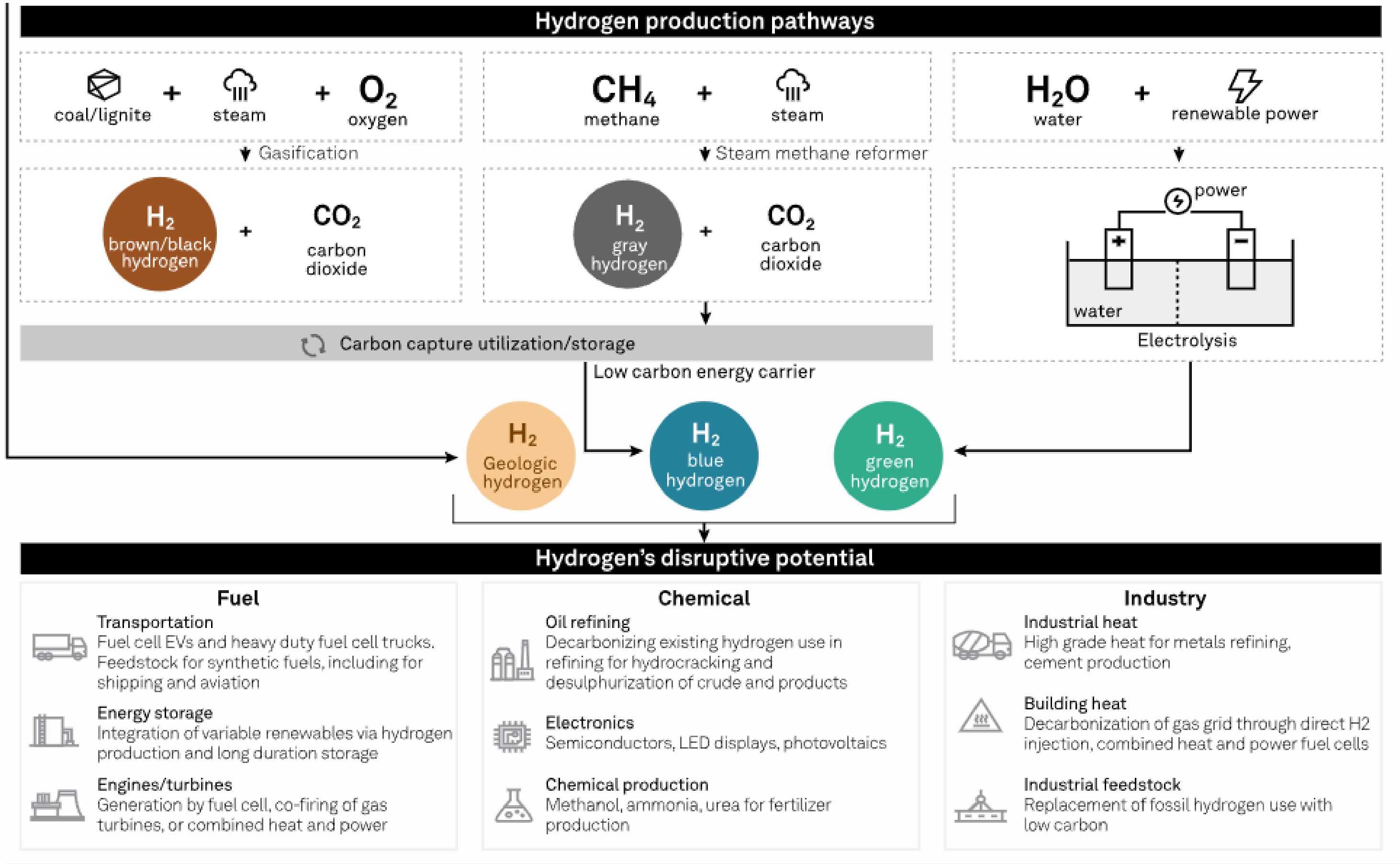


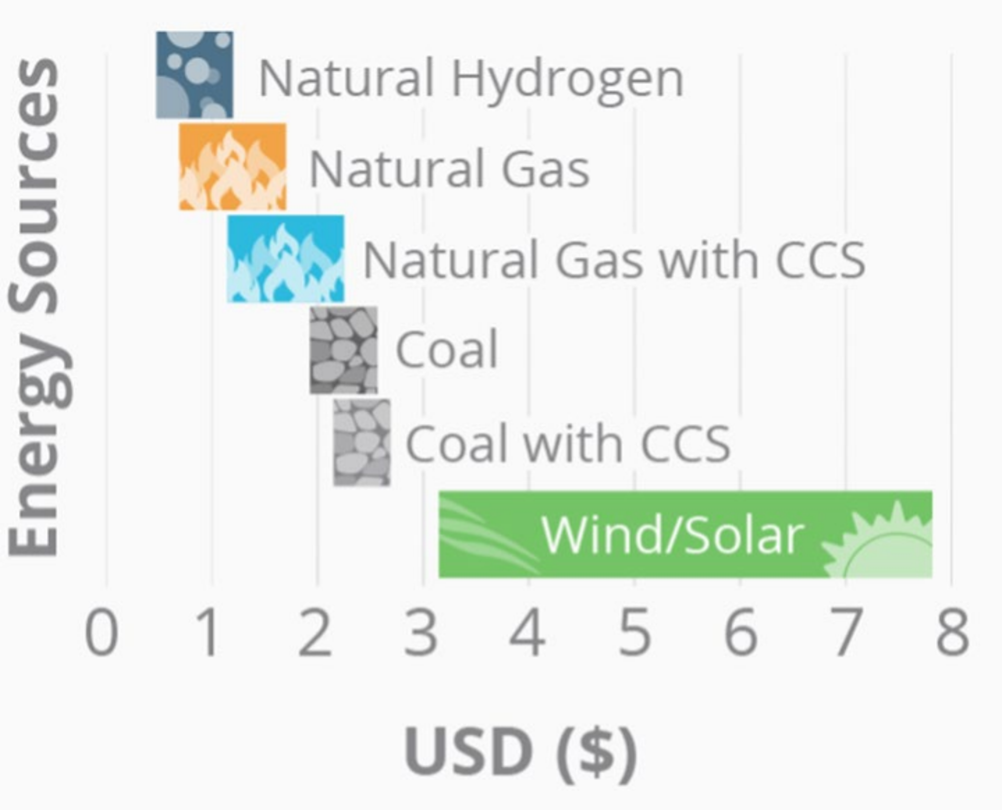
IEA Net Zero Global Roadmap 2023 Update

- *Today* – petroleum upgrading, fertilizer, petrochemicals
- *Future* – energy for hard-to-abate sectors — such aviation, steel manufacturing, industrial heating, mining
- Meeting this demand with blue and green hydrogen is likely to be expensive and mineral intensive
- Hydrogen is viewed exclusively as a medium for energy storage and transport **not a primary energy resource**
- What is the resource potential of natural hydrogen?



Methods for Producing Hydrogen and Estimated Cost Per KG

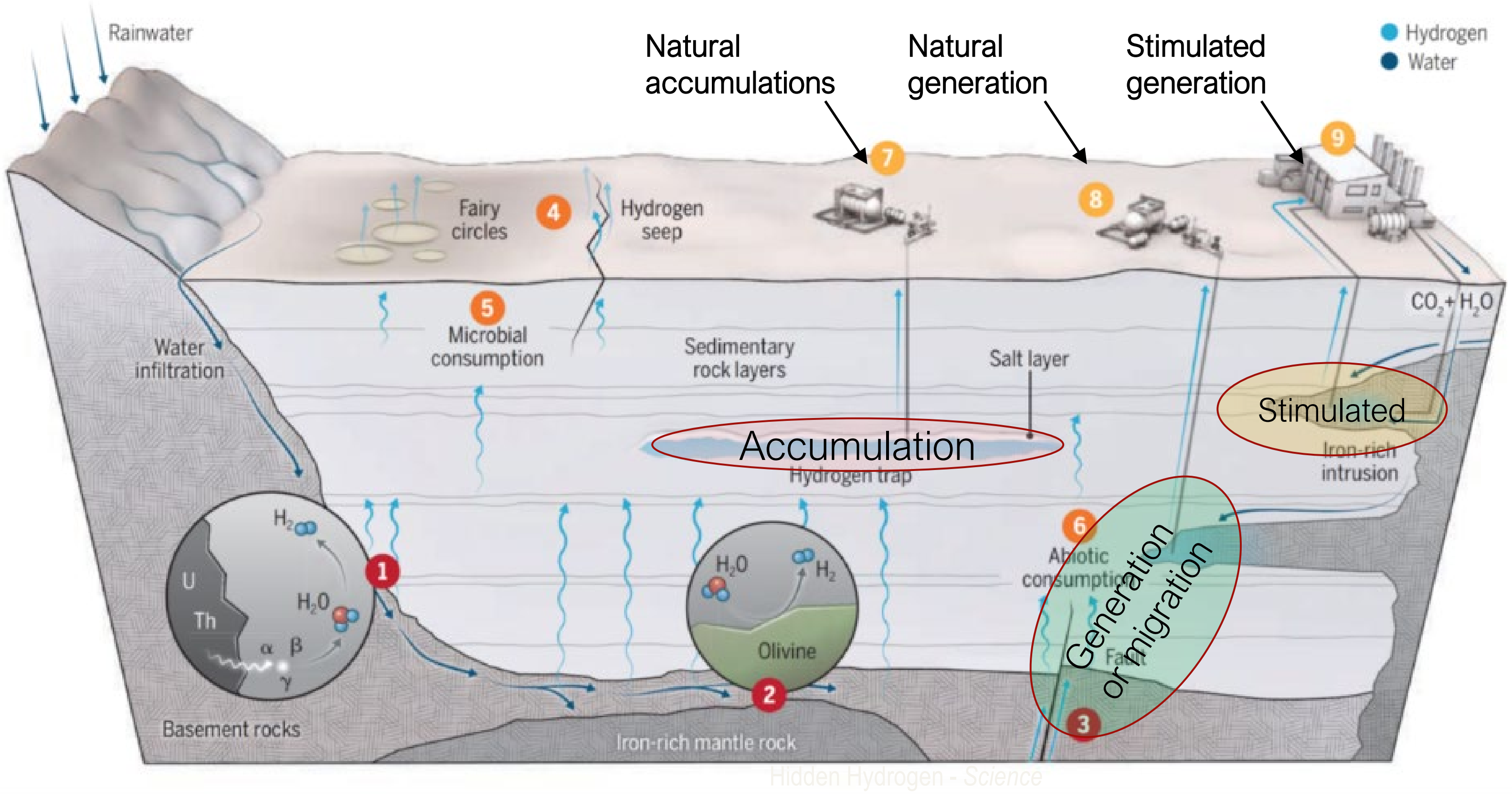




https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/101723-geologic-hydrogen-attracts-interest-as-a-clean-energy-source, https://energy.sandia.gov/programs/fossil-energy/subsurface-storage/geologic-hydrogen-capabilities/geologic-hydrogen/, Ball and Czado, 2022, IEA 2020

Hydrogen system model

3 conceptual types of exploitable H_2 resources



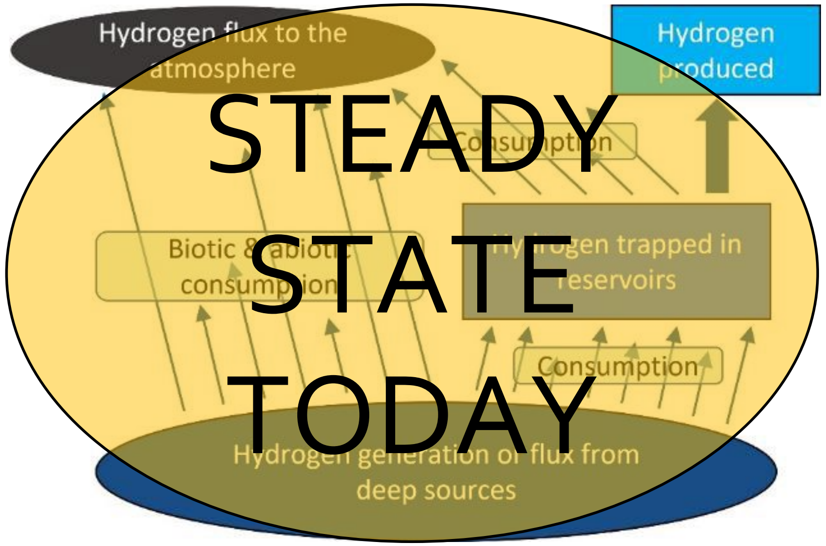
Hidden hydrogen, *Science* 2023 Modified by Geoff Ellis, USGS

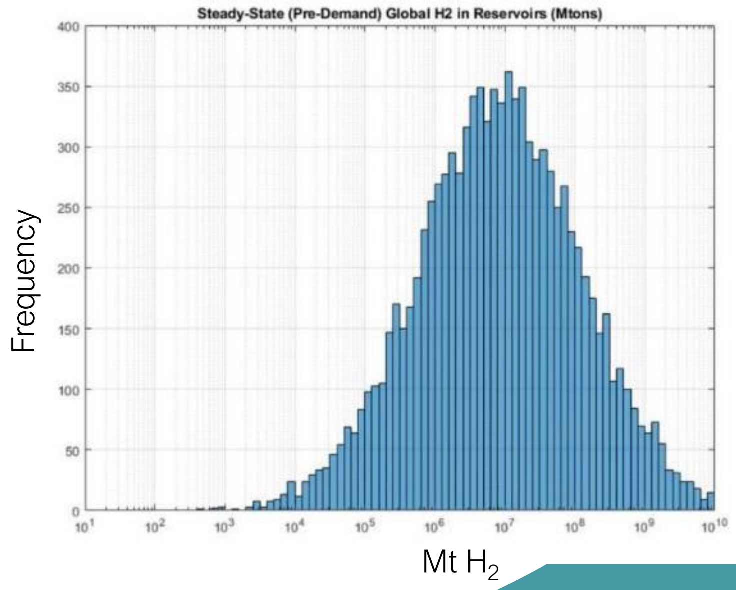
Viability of “natural” and “stimulated” generation play types is unknown

Global model in-place resource estimates only account for accumulations

Global Geologic Hydrogen Resource Model

- Inputs constrained by known hydrogen behavior (e.g., annual production, etc.) and analogues (e.g., petroleum, helium, etc.)
- In-place hydrogen amounts may range from thousands to billions of Mt with most likely amount ~5 million of Mt
- Most hydrogen is likely inaccessible – too deep, too far offshore, too small accumulations
- A few percent recovery would still supply all projected H_2 demand (~500 Mt/yr) for 100's of years

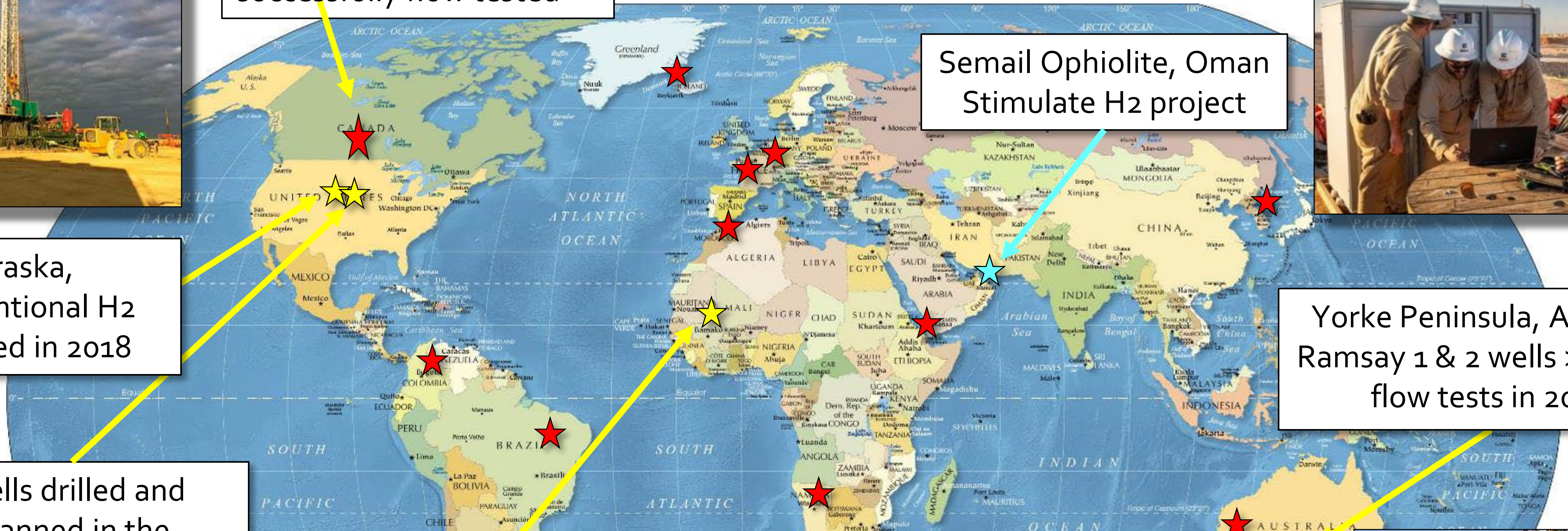




Ellis and Gelman, Science Advances

Geologic Hydrogen Resource Exploration - 200 wells drilled to date

Saskatchewan, drilled and successfully flow tested



Semail Ophiolite, Oman Stimulate H2 project

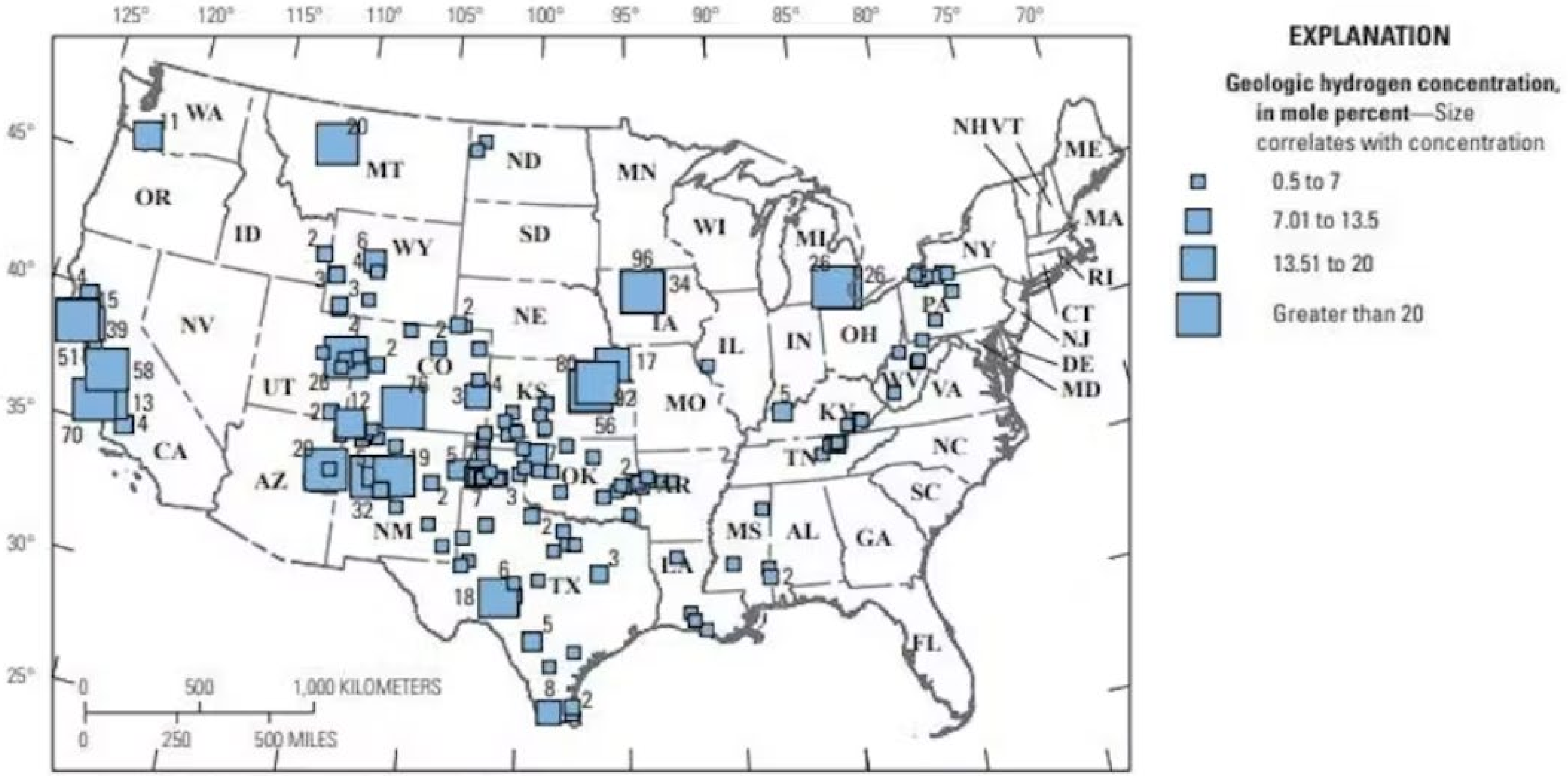
Nebraska,
First intentional H2 well drilled in 2018

Yorke Peninsula, Australia Ramsay 1 & 2 wells >70% H2 flow tests in 2024

Wells drilled and planned in the midcontinent rift Kansas, Nebraska, Iowa

Bourakébougou, Mali Accidental discovery in 2012, First H2 producing field in the world with a total 24 wells drilled

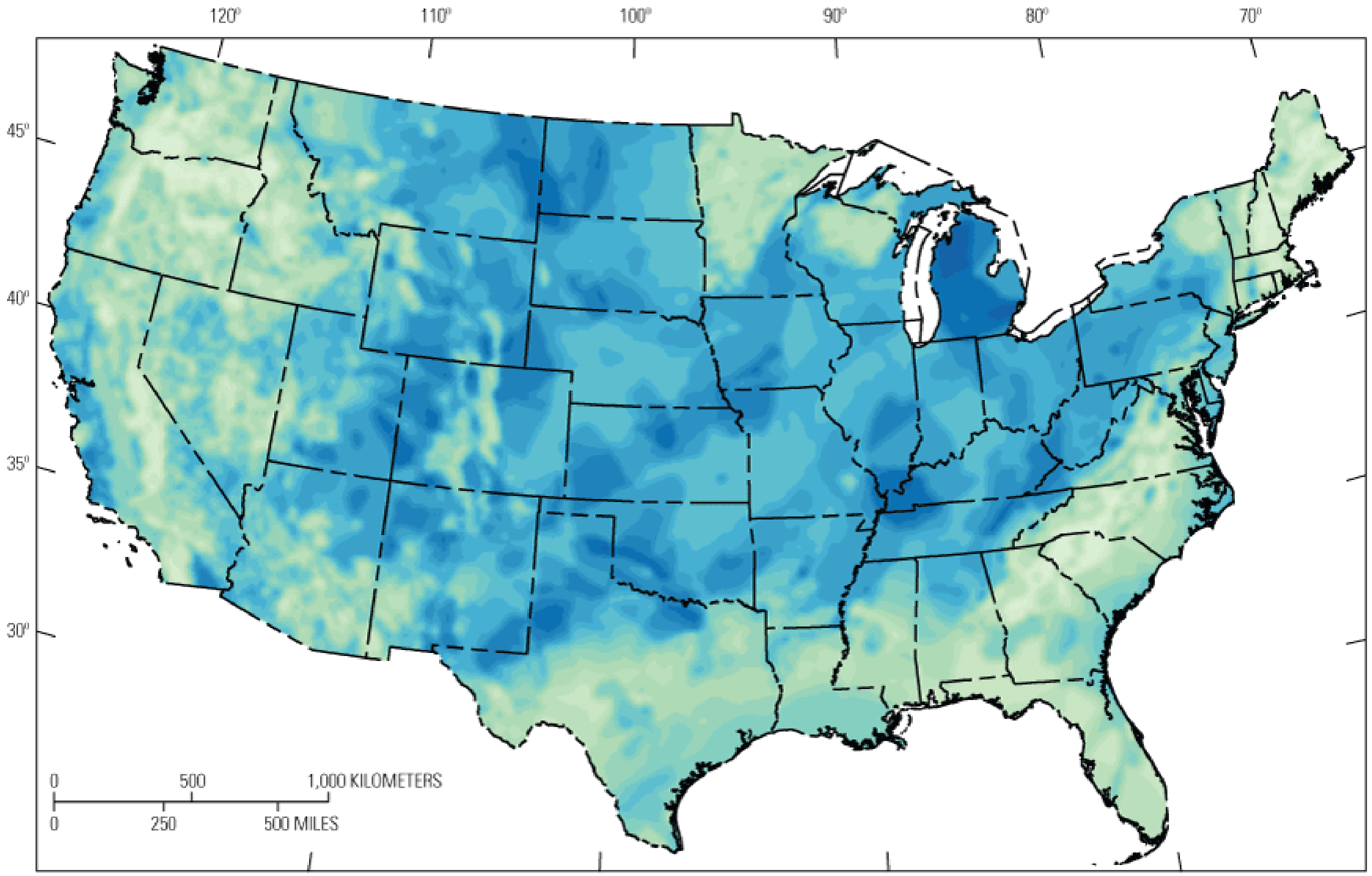
Modified From Geoff Ellis USGS



Base from U.S. Geological Survey, The National Map, 2021
Albers Equal-Area Conic, U.S. Geological Survey contiguous United States projection
North American Datum of 1983

USGS

USGS Prospectivity Map For Geologic Hydrogen



Base from U.S. Geological Survey, The National Map, 2021
Albers Equal-Area Conic, U.S. Geological Survey contiguous United States projection
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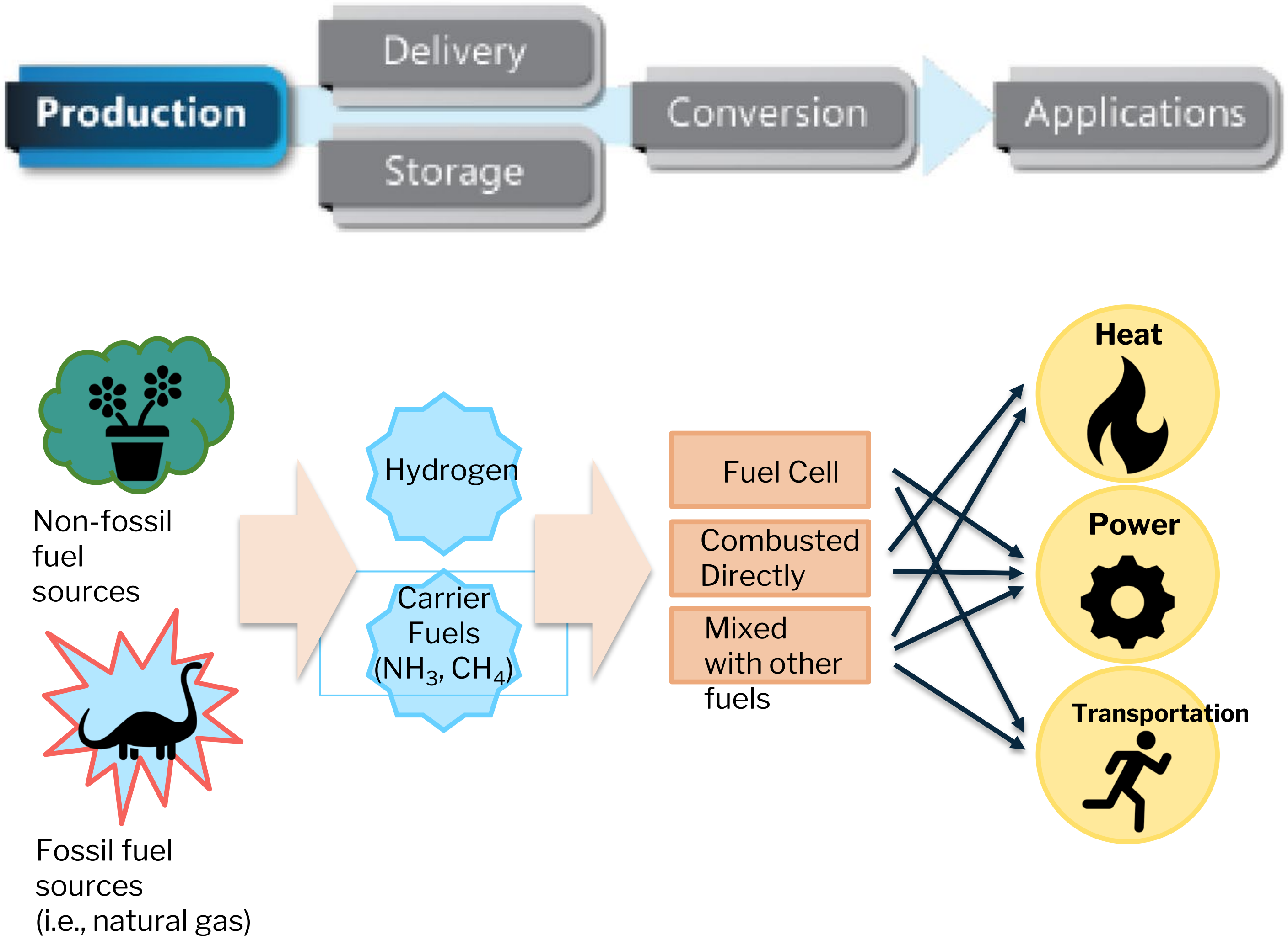
EXPLANATION

Median (P50) prospectivity

Hydrogen Infrastructure Needs and Possibilities in Alaska

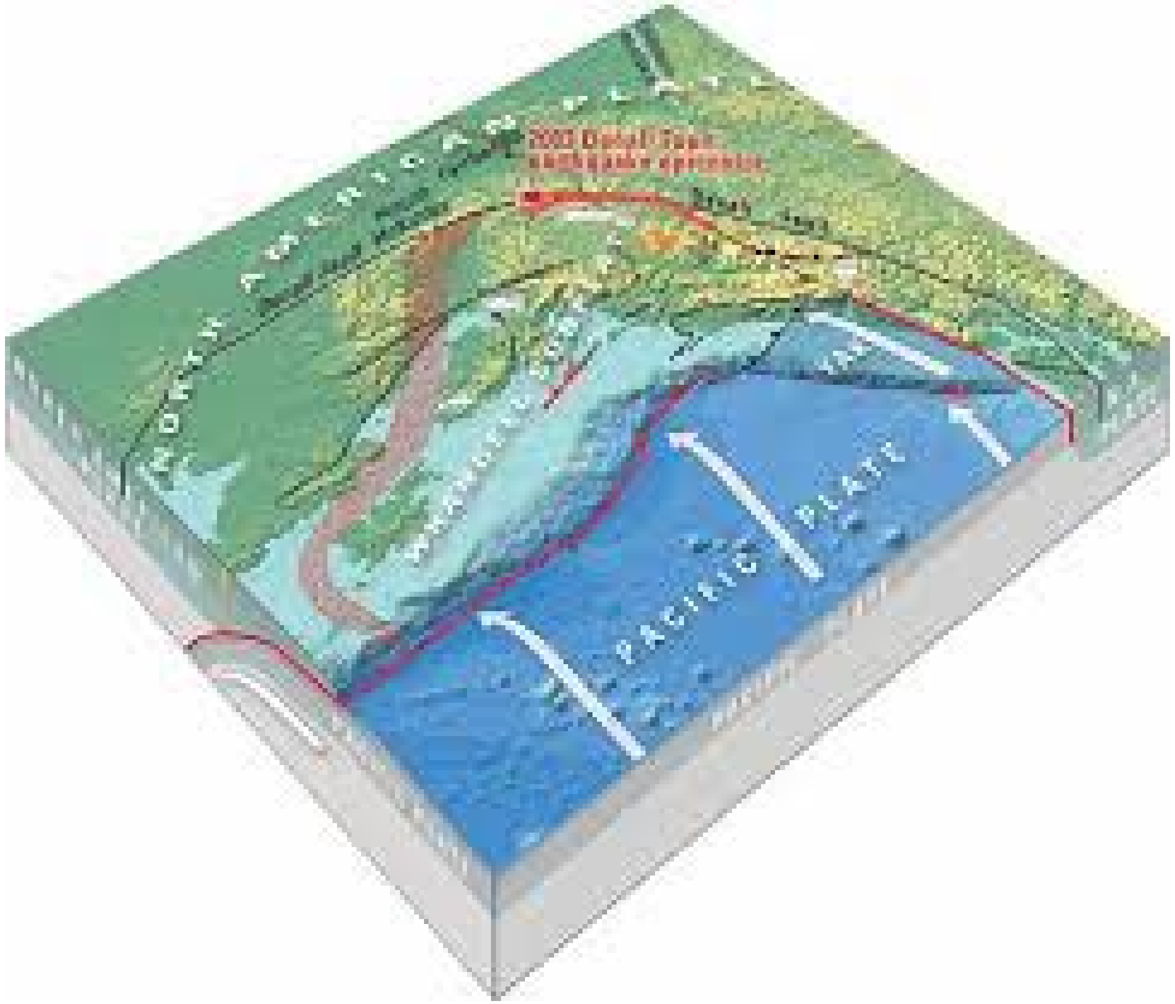


ALASKA OPPORTUNITIES

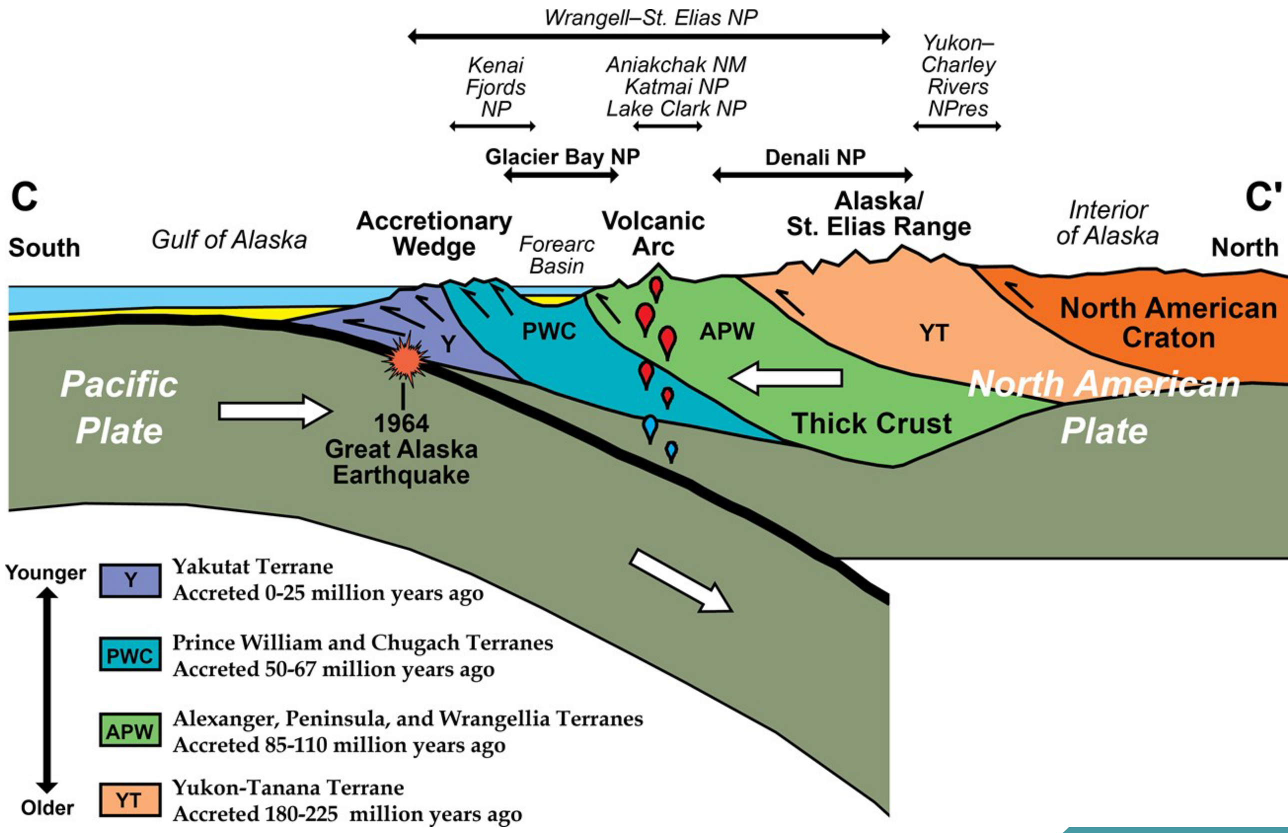
- Mining
- Remote Microgrids
- Railbelt
- Export

https://www.hydrogen.energy.gov/pdfs/hydrogen-program-plan-2020.pdf?utm_source=Daily%20on%20Energy%20111220_11/12/2020&utm_medium=email&utm_campaign=WEX_Daily%20on%20Energy&rid=208149

Large Quantities of Hydrogen Are Being Generated Beneath Us!



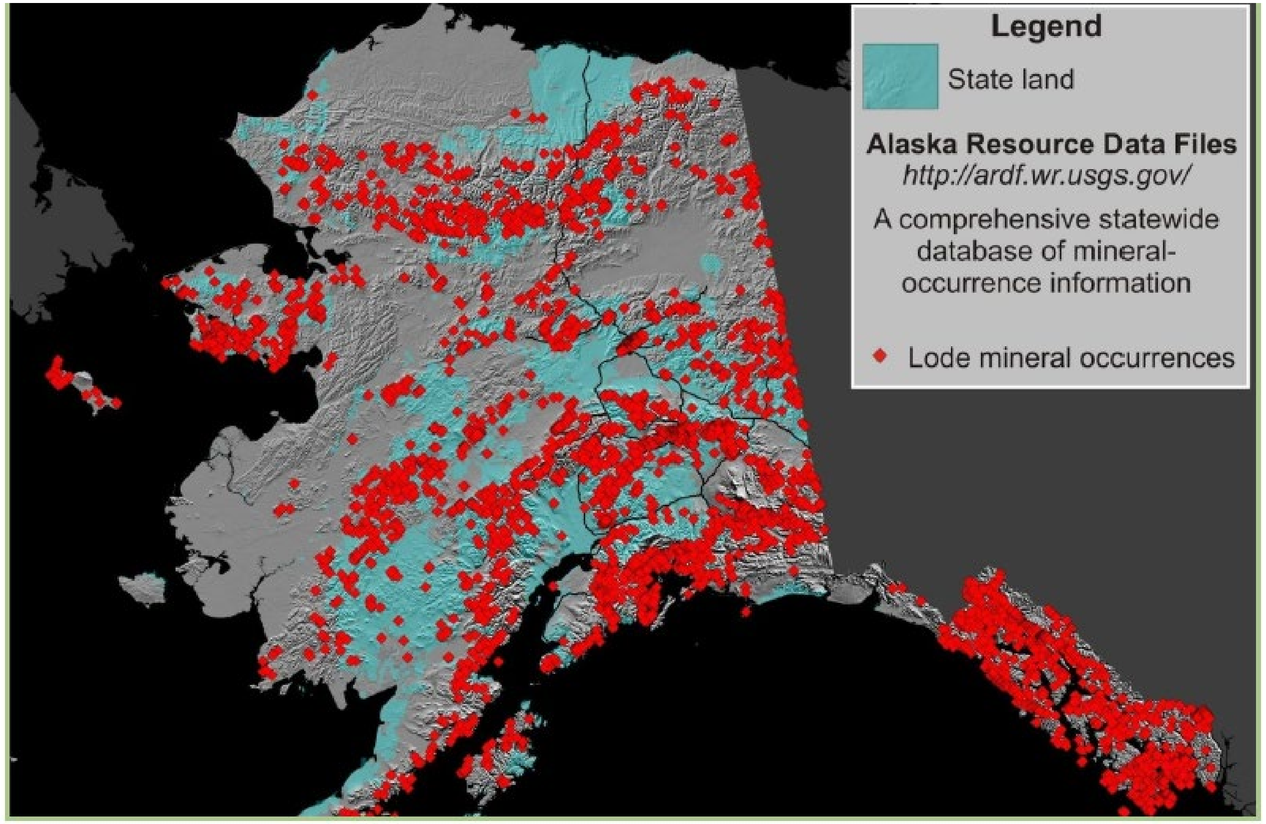
NASA



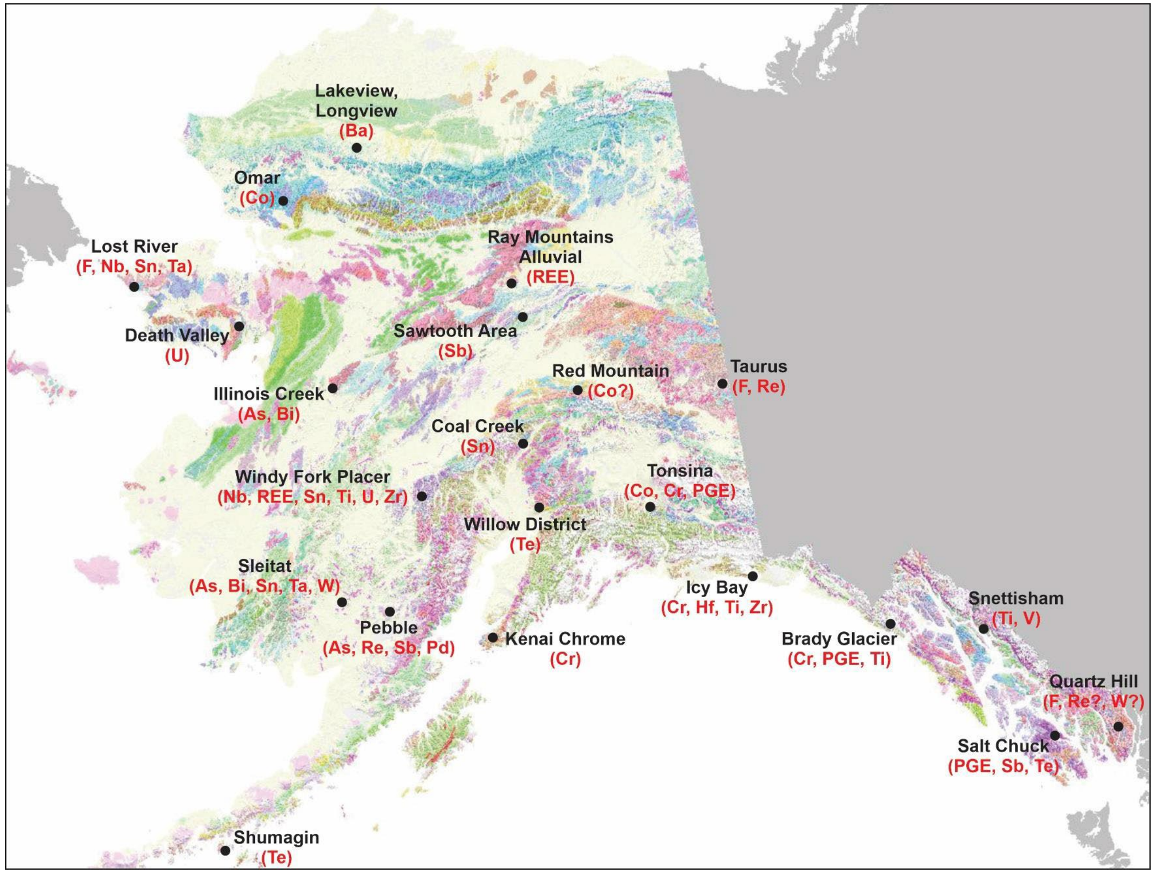
National Park Service

Many Potential Uses for Using Geological Hydrogen Near the Potential Source – Community Heat and Power , Mines, Transportation (Air, Sea and Land), and Military Sites

Example –Power for Mines

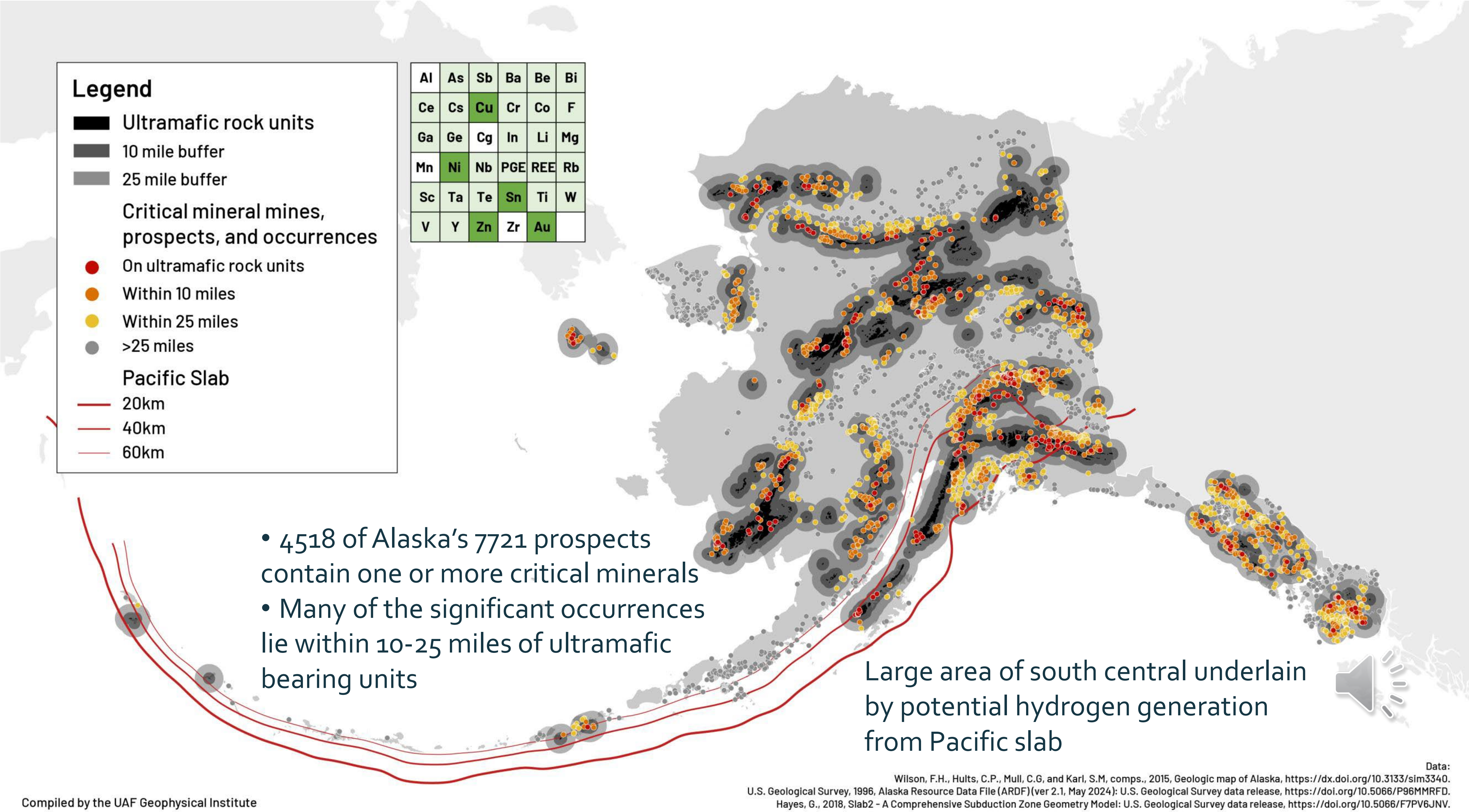


Alaska's Lode Mineral Occurrences



Select Significant Critical Mineral Occurrences

Sources DGGS and UAF



- 4518 of Alaska's 7721 prospects contain one or more critical minerals
- Many of the significant occurrences lie within 10-25 miles of ultramafic bearing units

Large area of south central underlain by potential hydrogen generation from Pacific slab

Data:
Wilson, F.H., Hults, C.P., Mull, C.G, and Karl, S.M, comps., 2015, Geologic map of Alaska, https://dx.doi.org/10.3133/sim3340.
U.S. Geological Survey, 1996, Alaska Resource Data File (ARDF) (ver 2.1, May 2024): U.S. Geological Survey data release, https://doi.org/10.5066/P96MMRFD.
Hayes, G., 2018, Slab2 - A Comprehensive Subduction Zone Geometry Model: U.S. Geological Survey data release, https://doi.org/10.5066/F7PV6JNV.

Critical Research Pathways Needed to Advance the Development of Geologic Hydrogen in Alaska
Preliminary work has begun in the first four areas

1. Resource Assessment Methodology and Assessments – USGS Alaska prospectivity mapping in progress
2. Regional Geological Assessment – AIEDA, UAF and Sandia National Lab in discussions with key mining companies for geological assessment in the Amber Mining District, Sandia National Labs has done limited geochemical analysis of eclogite, UAF has begun analysis of hyperspectral and airborne magnetic data, UAF grant proposal for assessing geological hydrogen in Livengood Mining District
3. Site Specific Geologic Assessment Element One Hydrogen and Critical Mineral Corp has acquired and is evaluating the Union Bay Southeast Alaska mineral prospect for geologic hydrogen
4. Transportation and Storage Studies – DOE SHASTA study in Cook Inlet identified seven potential storage reservoirs
5. Search for Hydrogen Seeps
6. Licensing Regimes for Federal and State Government
7. Research and Exploration Drilling
8. Economic Feasibility Studies
9. Environmental Standards and Baseline Studies Needed for Permitting and

Selected Conclusions from Alaska Geological Hydrogen Workshop in October 29-31 , 2024

- **Worldwide investment in research and exploration activities is rapidly increasing including in some US states, Europe, Middle East, and Australia. Private sector investment is in jurisdictions where regulatory permitting, licensing and baseline geoscience data are available.**

- **The geology of Alaska is highly favorable for geologic hydrogen. Of particular interest are areas in and near known and potential critical mineral and strategic mineral deposits and near remote interior and coastal communities**

- **A well-coordinated sustained national research program could dramatically and rapidly decrease the current high levels of uncertainty around the potential of this resource in the United States, including Alaska as well as assure that the United States has a leadership role in the development of this global resource.**

- **The wide variety of potential sources for generating geological hydrogen, coupled with the high cost of energy which limits both mining and community development and the presence of a skilled mining, oil and gas, federal state, native corporation and university workforce creates a great opportunity for developing a global testbed for increasing the understanding of the potential of geological hydrogen as an economic and environmentally preferred energy source.**