House Committee on Appropriations
Subcommittee on Interior, Environment, and Related Agencies
U.S. Geological Survey (USGS) Geomagnetism Program and MT Survey — FY20
Written testimony of David Jonas Bardin [redacted]
26 February 2019

Chair McCollum and Ranking Member Joyce,

As an individual, [1] I urge increased USGS funding (a) to expand its Geomagnetism program and (b) to manage completion of a geophysical, earth-conductivity survey of the contiguous United States (CONUS). Both are vital to protect critical infrastructure, including our electric power grid, from natural and hostile electromagnetic hazards — events such as solar ("space weather") storms and EMP (electromagnetic pulse) attacks. Utility firms and their consultants, the North American Electric Reliability Corporation (NERC) and Electric Power Research Institute (EPRI), rely upon these geomagnetic and conductivity data to extent data have been collected. There are no data for such states as Texas and most of California.

Congress rejected FY18 and FY19 proposals to zero out Geomagnetism. [2] This Committee explained: [3]

> The USGS Geomagnetism program is part of the U.S. National Space Weather Program (NSWP), an interagency collaboration that includes programs in the National Aeronautics and Space Administration, the Department of Defense, the National Oceanic and Atmospheric Administration, and the National Science Foundation. The program provides data to the NSWP agencies, oil drilling services companies, geophysical surveying companies, and electrical transmission utilities. **The Committee** funds this program at the fiscal year 2018 enacted level and **expects this work to continue.**

I hope FY20 proposals, heeding that wisdom, will continue Geomagnetism data and research work and seek (a) to expand America's insufficient network of ground-based geomagnetic observatories and (b) to complete the magnetotelluric (MT) Survey begun by the National Science Foundation (NSF) as part of its EarthScope program (which ended in FY2018).

EarthScope included geophysical mapping that uses an Earth imaging technique known as the MT method — overseen by Incorporated Research Institutions for Seismology (IRIS) and executed by Oregon State University (OSU). They were charged with mapping three-dimensional (3-D) geological structure of CONUS; specifically variation in electrical properties

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[1] Retired member of Arent Fox LLP submitting as individual citizen on my own behalf.

[2] See https://www.usgs.gov/natural-hazards/geomagnetism; and Finn & Love, *Proposed elimination of USGS Geomagnetism Program* (June 3, 2017), available at https://geohazards.usgs.gov/pipermail/geomag-data/2017-June/000026.html.

[3] House of Representatives Report 115-765 to accompany H.R. 6147 (June 19, 2018) [pages 32-33, emphasis added] reaffirmed n Explanatory Statement Regarding H. J. Res. 31 (Feb. 14, 2019) at PDF page 306 of 612.

of crust and mantle. EarthScope data obtained by OSU were quickly put in the public domain for use without restriction. But there are no data for all or part of 14 southern tier states.

NSF's funding purposes were entirely for geological mapping and related benefits, but others discovered early in this decade that MT data obtained proved of critical importance to evaluating and mitigating space weather risk to electric power transmission grids. Recent studies suggest these data have similar importance for protecting critical infrastructure from EMP.

There has been broad uptake of these MT data by space weather researchers in USGS Geomagnetism, other government agencies, academic institutions and industrial laboratories.

NSF's now-ended program (plus USGS mapping of Peninsular Florida and small areas elsewhere) supported completion of MT Survey for nearly ⅔ of CONUS. Researchers found large regional variations in ground conductivity with some extremely high geomagnetic hazard concentrations (for example in Minnesota and Maine), to which electric utilities can respond (for example, American Transmission Company and Central Maine Power Company).

Research into impact of regional variations in ground conductivity seen over the ⅔ of CONUS for which there are MT data indicate that critical infrastructure (such as power grids) in areas still without MT data are just as likely to face high risk from space weather and EMP as the rest of CONUS.

Electric power researchers make use of MT Survey data combined with magnetic field measurements from a sparse network of magnetometer stations. [4] CONUS has a magnetometer shortage. USGS Geomagnetism has only six magnetic observatories in CONUS: [5]

- Two (in Virginia and Mississippi) in the Eastern Interconnection where most Americans live;
- four in the Western Interconnection (in Colorado, Arizona, California, and Washington); and
- none in the Texas Interconnection (since 2009 [6]). See map, Appendix B.

I urge you to expand USGS Geomagnetism annual budget line from $1.9 million to $4 million, keeping in mind that U.S. Air Force will end its $560,000 annual contribution this year. I assume Geomagnetism will continue to receive a share of overall USGS annual Facilities line for maintenance of its aging facilities (which share has come to about $500,000 annually). Our safety and national security need a robust Geomagnetism program.

I also urge you to appropriate $5.5 million to USGS to manage and fund completion of the CONUS MT Survey. I assume USGS and OSU would want to work together, preserving

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[4] See EPRI, *Use of Magnetotelluric Measurement Data to Validate/Improve Existing Earth Conductivity Models* (Technical Update, Dec. 2018); and Love et al., *Extreme-value geoelectric amplitude and polarization across the Northeast United States* (Space Weather, Dec. 2018 - in press).

[5] It also has five magnetic observatories in Alaska and one each in Hawaii, Guam, and Puerto Rico.

[6] In July 2009, USGS closed and subsequently dismantled its Del Rio, Texas, observatory for budgetary reasons.

OSU's existing instrumentation capability (amassing perhaps the largest capacity in the world for carrying out large-scale MT mapping, specifically to meet needs of previous NSF EarthScope requirements), to complete required MT mapping — with continuity of data acquisition, processing and analysis procedures in order to achieve consistent calibration of MT data across all of CONUS.

In a Report to Congress, [7] which Senate Appropriations Committee released in May 2018, the National Oceanic and Atmospheric Administration (NOAA) called out as

> "one of the highest priority expected gaps and potential gaps in data needed for geomagnetic storm forecasting" the likely failure to complete a magnetotelluric (MT) survey of the contiguous United States, with the result that "accurate forecasts of the impact to the electric power grid will not be possible for one third of the Nation."

NOAA there reported:

> **Mitigation strategies:** Funding is required to complete the survey for the remaining third of the Nation. The cost of completing the [MT survey] was estimated by USGS at $5.5 million (over five years).

"[B]ut there are presently no plans (nor is there any funding identified) to complete this survey for ... one third of the Nation."

Respectfully submitted, *David Jonas Bardin*

Appendix A: Examples of other users of crucial USGS Geomagnetism data products

Apart from service to NOAA's Space Weather Prediction Center (SWPC) summarized in text, NOAA's National Centers for Environmental Information (NCEI) wrote (June 9, 2017):

***Summary**. Loss of the geomagnetic observatory and global geomagnetic Dst index service provided by the observatories of the USGS Geomagnetism Program will result in the inability of the U.S. Government to satisfy the military requirement (MIL-PRF-89500A) that supports critical military and civilian navigation systems. The USGS Geomagnetic Program provides mission critical monitoring of the Earth's changing magnetic field.*

***Summary**. Loss of the geomagnetic observatory and global geomagnetic Dst index service provided by the observatories of the USGS Geomagnetism Program will result in less accurate geomagnetic referencing and increased health, safety and environmental (HSE) risk associated with directional drilling in the entire U.S. geographical area.*

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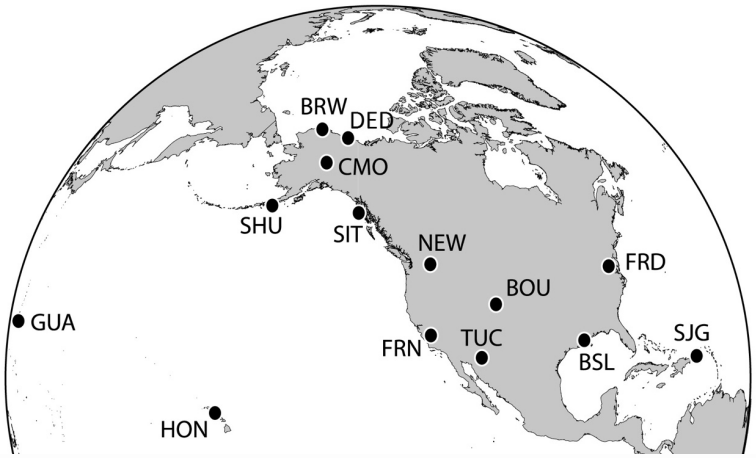
[7] Available at: http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20180608-5007.

Appendix B: Locations of USGS Geomagnetism's Magnetic Observatories and Locations of all INTERMAGNET Magnetic Observatories



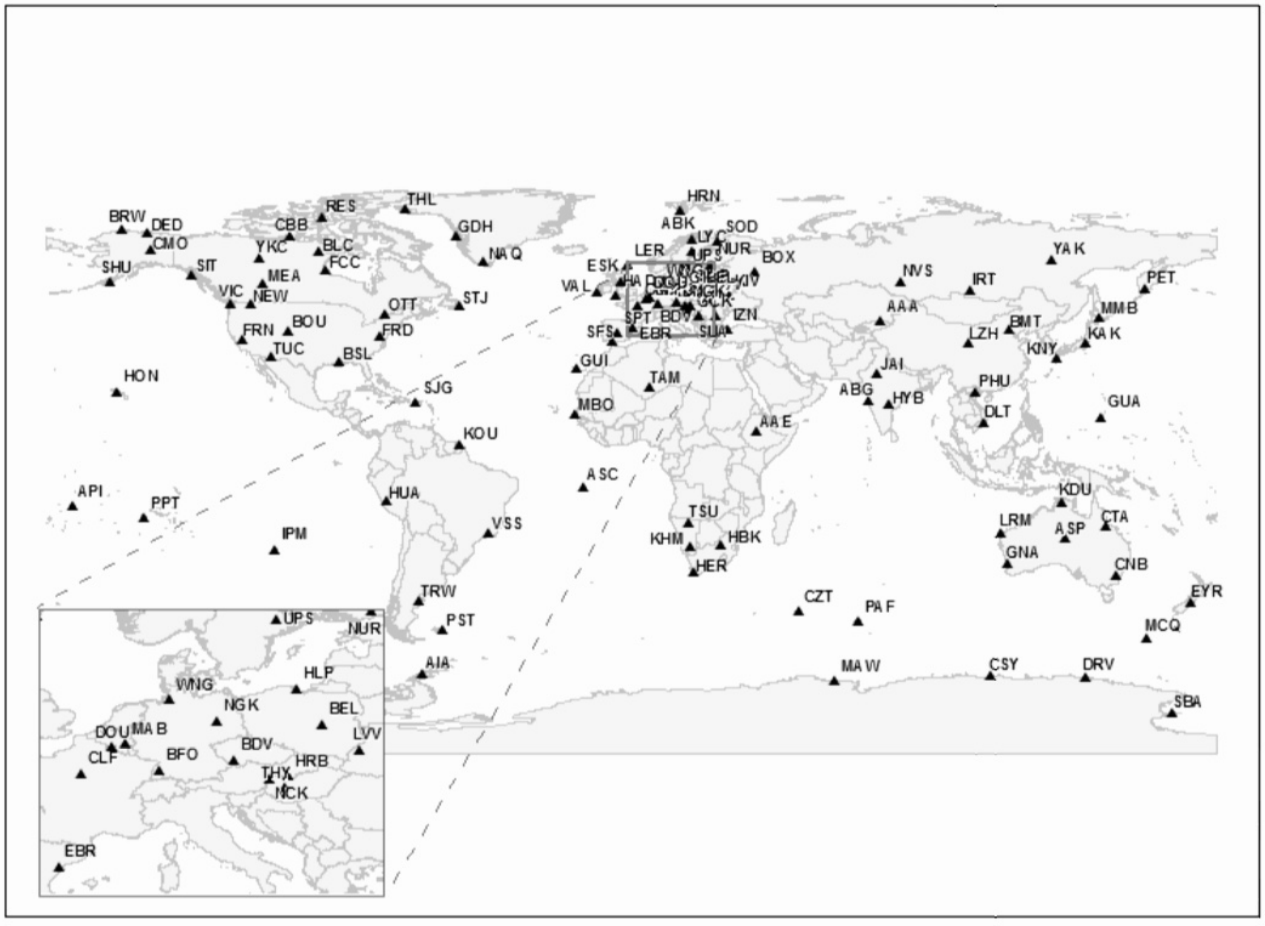


Figure 1: Map of the INTERMAGNET global network of magnetic observatories (www.intermagnet.org). USGS observatories are located in the contiguous United States (BOU, BSL, FRD, FRN, NEW, TUC), Alaska (BRW, CMO, DED, SHU, SIT), Hawaii (HON), Puerto Rico (SJG) and Guam (GUA).