geoconvention
Virtual Event
September 13 - 15
2021

An Innovative Approach to Geothermal Prospecting through Interactive Analytics: Western Canada Applications

Phil Harms and Dan Kalmanovitch
GEOSEIS Inc.

Summary

Geothermal is a source of energy for both base-load electricity generation and direct-use heat applications. In recent years, there has been exciting pioneering geothermal studies and early development across Western Canada. Due to the abundance of low cost power from a variety of energy sources and the geological endowment of Western Canada, exploitation of geothermal energy has a unique set of challenges to compete in this market.

From southwest British Columbia with the Mount Meager volcanic complex which last erupted 2,400 years ago, to southeast British Columbia having no magmatic heat source but numerous hot springs and large fault zones, and then to the deep sections of the Western Canadian Sedimentary Basin with hot sedimentary aquifers, there are highly varied areas of geothermal potential in Western Canada.

A challenge is that over such a large area involving different geothermal systems, jurisdictions, and datasets, it is difficult to assess, compare and rank identified opportunities while also looking for unidentified sites and anomalies regionally. To analyze and characterize opportunities, technical information as well as infrastructure and developability indicators must be considered.

The “Interactive Analytics” approach is an effective way to investigate geothermal prospectivity at a regional scale through an objective, data-driven workflow. This approach was first presented at the African Rift Geothermal Conference in November 2020 for the entire East African Rift System. In this presentation, the study area is the Western Canada Cordillera and sedimentary basin. In this approach, geothermal project indicators are identified and extracted from available datasets. Prospectivity attributes are generated to compare surface and subsurface feature relationships and potential geothermal resources at depth. Spatial relationships with other features such as distance to roads, power lines, and centers of human activity and energy use are generated to further frame geothermal opportunities.

The Interactive Analytics approach, especially at a regional scale, is not a replacement for high quality geoscience and localized site exploration. It provides an opportunity to develop a data driven understanding of a region and systematic ranking of opportunities resulting in targeted exploration efforts maximizing precious exploration capital. The methodology can highlight potential geographic synergies between geothermal potential, emerging energy developments, existing industry and local stakeholders. The Interactive Analytics methodology in this case, will

be applied to the Western Canada energy landscape and expanded using the rich datasets available in the region.

Method

The methodology divides a study area into a dense number of grid points and assigns attributes to these points. Attributes can be explored across multiple visualizations such as cross plots and graphical charts. Filtering and selecting can be used and the results are interactively viewed in the map domain. Attributes are processed in such a way that spatial information is enhanced for these types of analyses. A Python script automates the geoprocessing tasks allowing for rapid iteration, parameter testing, optimization, and idea generation (Figure 1).

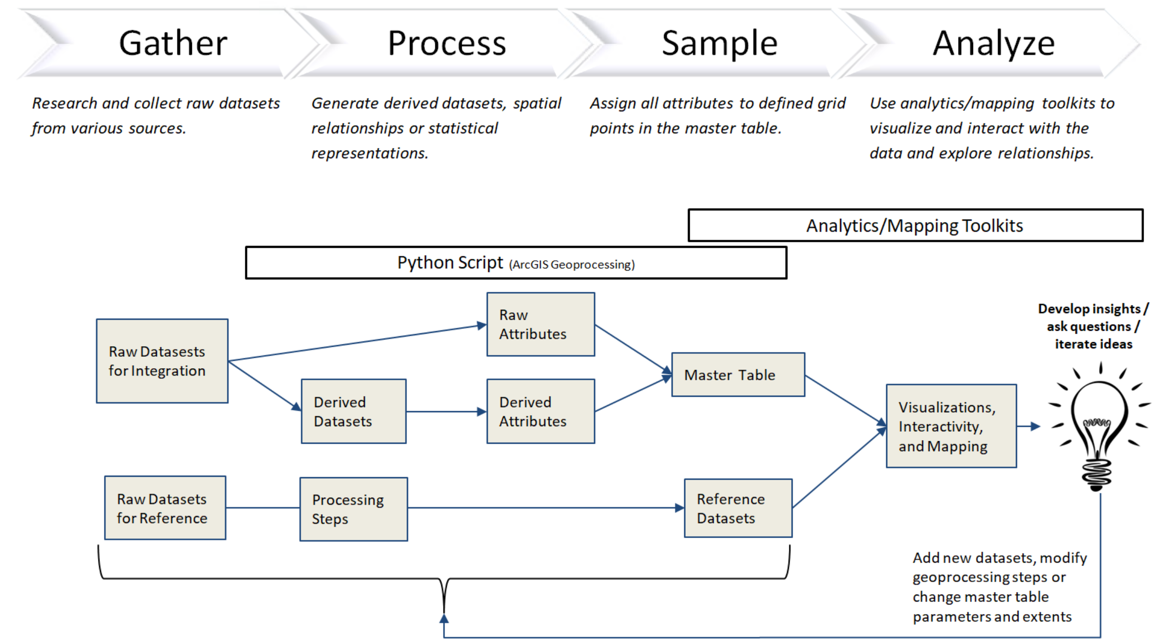

Figure 1: Data analysis flow diagram

Identifying the right data types to use at certain scales is important. At a regional scale, longer period datasets and trends can be utilized. To demonstrate the methodology, this paper focuses attributes such as existing oil and gas fields, regional heatflow, well data, industrial activity, and infrastructure data. The data gathered for this study is grouped into three attribute classifications:

1. **Geothermal Resource Indicators** are measures (direct) or proxies (indirect) of the geothermal resource. In general, these can be further classified into heat, permeability, or fluid indicators (Hinz et al, 2016).

2. **Infrastructure Indicators** are attributes that influence the developability of geothermal projects such as powerline infrastructure. Market demand such as population densities and power/heat intensive industries are also included.
3. **Reference Data** include attributes that can be used to contextualize the analysis such as provincial and basin boundaries.

Attributes can be raw or derived. Raw attributes are assigned from source datasets with minimal processing applied and are intended to honour the source datasets as best possible. Derived attributes are enhanced from the source datasets through a sequence of geoprocessing steps (Figure 1). Data specific techniques are used for interpolation, aggregation, and resampling. The data are reorganized into a master table with one row per grid point and one column per attribute.

The master table and other reference datasets are loaded into analytics and mapping toolkits. These tools have been configured to visualize and interact with the data and explore relationships.

The analytics tool is configured so that attributes can be plotted against each other discreetly joined at the grid point. These relationships are interactively explored in cross plots, maps, and other visualizations. For this analysis, no stochastic relationships were specified.

The iteration speed and rapid “what if” scenario building is the key part of the workflow. As concepts are developed, rapid iteration allows for the identification and integration of new datasets, modification of geoprocessing steps or changes to master table parameters and extents. A Python script facilitates repeatable and efficient data iterations.

Prospect scale mapping is not targeted in this paper. However, the methodology can be applied with appropriate data at continually decreased scales eventually to the prospect level.

Results

Analysis pathways will be explored using the Interactive Analytics methodology and presented to the audience.

Summary

The Interactive Analytics approach provides the means to explore intuitive relationships and relate to maps. Additional datasets can continually be added, and existing datasets improved. The power of such an iterative, map-based analytics approach is that it allows for rapid interrogation and scenario building regionally. Working with such an analysis allows exploration of relationships in real time, triggers previously unthought-of questions and provides the means to answer them. This methodology provides a versatile approach to understanding, framing, and ranking. The only limitations are the users' creativity.

References

Center for International Earth Science Information Network (CIESIN)/Columbia University, and Information Technology Outreach Services (ITOS)/University of Georgia. 2013. Global Roads Open Access Data Set, Version 1 (gROADSv1). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). Downloaded from http://sedac.ciesin.columbia.edu/data/set/groads-global-roadsopen-access-v1 [DATE DOWNLOADED July 10, 2020]

Harms, P., Kalmanovitch, D., Birnie, D., Hickson, C.J. "An Innovative Approach to Geothermal Prospecting through Interactive Analytics". Proceedings, 8th African Rift Geothermal Conference, Nairobi, Kenya: 2 – 8 November 2020

Hickson, C.J., Huttrer, G., Kunkel, T., Majorowicz, J., Yehia, R., Lund, J., Raffle, K., Moore, M., Woodsworth. G., Boyd, T. and Hjorth, L. 2016 "Direct Use Geothermal Resources in British Columbia, Section A Summary of Findings". Geoscience BC, Report 2016-07, 189 p.

Hickson, C.J., Huttrer, G., Lund, J., and Boyd, T. "Direct Use Geothermal Resources in British Columbia, Section B Roadmap". *Geoscience BC, Report* 2016-07, 104 p.

Hickson, C.J., Yehia, R., 2014 "The Geothermal Exploration and Development Process: Graphical Representation Path to Optimal Decision Making" *GRC Transactions*, Vol. 38, 2014, 377 p.

Hinz N, Coolbaugh M, Faulds J, Shevenell L, and Stelling P, "Regional quantitative play fairway analysis: Methodology Global Examples and Application for the East African Rift System" Proceedings*, 6th African Rift Geothermal Conference Addis Ababa, Ethiopia, 2nd – 4th November 2016*

IEA (2019), *Africa Energy Outlook 2019*, IEA, Paris https://www.iea.org/reports/africa-energy-outlook-2019

Palmer-Wilson K, Walsh W, Banks J, Wild P, "Techno-Economic assessment of Geothermal Energy Resources in the Sedimentary Basin in Northeastern British Columbia, Canada" *Geoscience BC Report* 2018-18

The European Space Agency (ESA), African Land Cover, Released October 2017. https://www.esa.int/ESA_Multimedia/Images/2017/10/African_land_cover

UNEP-WCMC and IUCN (2020), Protected Planet: [Terrestrial Portions; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [July/2020], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

U.S. Geological Survey; Map showing Geology, Oil and Gas Fields, and Geologic Provinces of Africa, Publication Date: 200206; version 2.0 ed. 2; vector digital data http://energy.cr.usgs.gov

U.S. Geological Survey Center for Earth Resource Observation and Science (EROS), National Aeronautics and Space Administration (NASA), National Geospatial-Intelligence Agency (NGA), Shuttle Radar Topography Mission DTED® Level 1 (3-arc second) Data: U.S. Geological Survey Center for Earth Resource Observation and Science (EROS), Sioux Falls, South Dakota, USA.

Varet J, "Geothermal resource along borders: The Rwanda-DRC case" *Proceedings, 7th African Rift Geothermal Conference, Kigali,* (2018).

VOTW, Global Volcanism Program, 2013. *Volcanoes of the World*, v. 4.9.0 (04 Jun 2020). Venzke, E (ed.). Smithsonian Institution. Downloaded 13 May 2020. https://doi.org/10.5479/si.GVP.VOTW4-2013

Wood J and Guth A; 2014 "East Africa's Great Rift Valley: a complex rift system" Michigan Technological University; https://geology.com/articles/east-africa-rift.shtml

WorldPop (www.worldpop.org - School of Geography and Environmental Science, University of Southampton; Department of Geography and Geosciences, University of Louisville; Departement de Geographie, Universite de Namur) and Center for International Earth Science Information Network (CIESIN), Columbia University (2018). Global High Resolution Population Denominators Project - Funded by The Bill and Melinda Gates Foundation (OPP1134076). https://dx.doi.org/10.5258/SOTON/WP00647