Digital Rocks Portal, Proposed Effort to Adapt an NSF Geomaterials Data Curation Tool for FE R&D in EDX

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digitalrocksportal.org

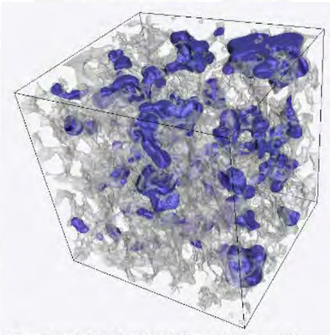
Digital Rocks Portal

Released in 2015 with a mission to:

• Organize and preserve images and related experimental measurements of different porous materials,

• Improve access to them for a wider community of geosciences and engineering researchers not necessarily trained in computer science or data analysis, and thus

• Enhance productivity and enable scientific inquiry and engineering decisions founded on a data-driven basis.

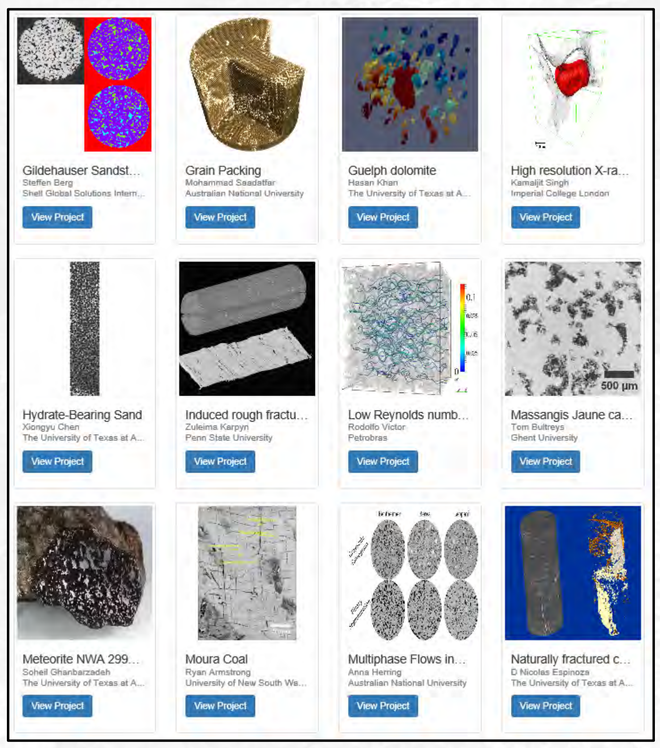


Direct simulation of residual phase (disconnected blobs in blue) in Berea Sandstone (imaged based pore grain surface shown in transparent gray).

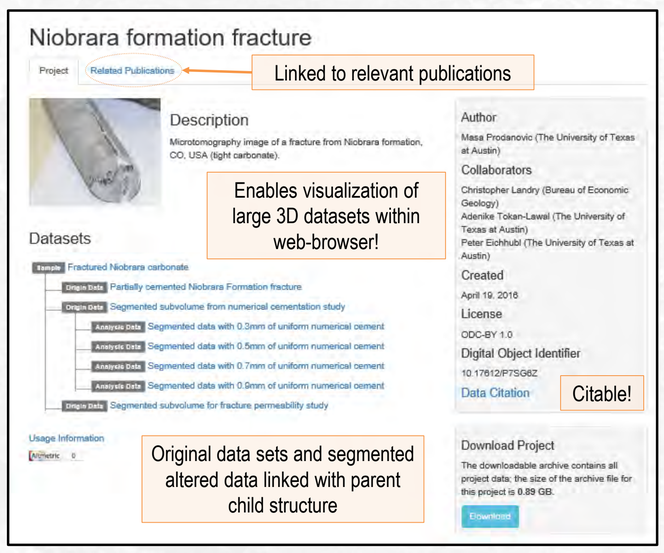
Enabling Data Discoverability and Citations

- Part of EarthCube collaborative to enhance access to Geoscience data, models and resources.
- Member of the EarthCube Council of Data Facilities.
- Registered in Registry of Research Data Repositories.
- Registered data repository for Geosciences Data Journal.
- Issues digital object identifiers (DOIs) for referencing and discoverability.

Wide Variety of Datasets, Simulation and Experimental



Built for Digital Data Sharing and Direct Viewing/Analysis



Abstract

Flow and transport processes arise routinely in the subsurface, and understanding these multiscale processes is critical for engineering applications such as carbon sequestration, enhanced oil recovery, and contaminant transport. New data sources, the most powerful being 3D imaging, have allowed many porous media processes to be observed directly or simulated in detail for the first time, as well as understand flow mechanisms that directly impact oil recovery. Technologies such as computed tomography (CT), X-Ray microtomography (μCT) and focused ion beam scanning electron microscopy (FIBSEM) provide a window into multiscale processes within geologic materials that span a wide range of length and time scales. Acquisition, analysis and simulation based on these images (a.k.a. digital rock physics) provide a framework that can be used to extract insight from these large data sets, as well as perform upscaling.

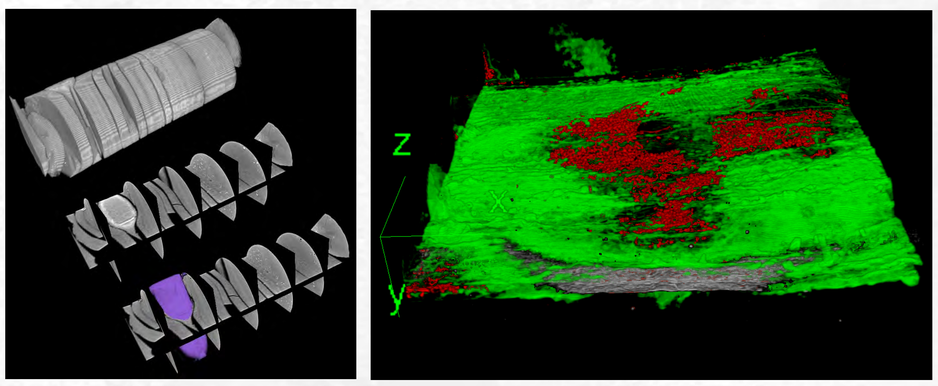
Generating quantitative insight from raw data obtained from light sources depends on computational capabilities to perform scalable data analysis, simulations, and visualizations and link experimental data across spatial and temporal scales. While it is not atypical to perform multi-physics simulations based on images, these require high performance computing (HPC) resources for pre-processing stages, simulation input and long term storage. Significant scientific opportunities can be realized developing methods that not only study transport behavior within individual samples, but consider statistical approaches to aggregate observations from many different samples.

To address the former we propose to:
(1) Improve preservation of, and increase accessibility to large-scale digital rocks data, specifically focusing on those produced at DOE light sources
(2) Integrate those results with data and simulation tools on different length/time scales available through Energy Data Exchange (EDX) (https://edx.netl.doe.gov) platform.

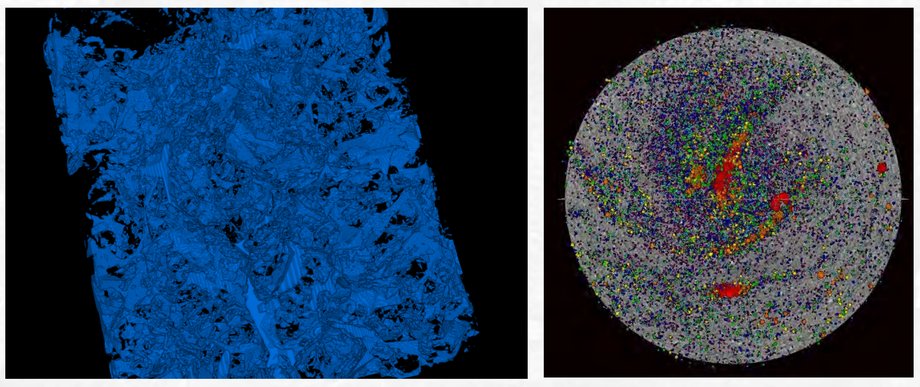
Connecting the DRP and EDX platforms by extending and integrating their data and models constitutes a unique pathway to enabling analysis of large datasets in digital rocks physics. In particular we will facilitate ingest, curation, and visualization of digital rocks data from National Energy Technology Laboratory (NETL) and from Sandia National Laboratory (SNL) to DRP. In turn, interoperability with EDX will enable a broader audience to discover and access disparate data sources and models at different scales. The NETL and SNL resources will be relevant to the rest of the National Laboratories. The proposed tools will enable geoscientists and subsurface engineers not traditionally trained in computer science, to effectively use large datasets and HPC to pursue scientific discovery.

“The whole is greater than the sum of its parts.” - Aristotle

By bringing DRP and EDX together we will enhance the visibility and capabilities of both systems and enable greater access of digital rocks data for multiple lines of research.



Core characterization and reactive flow in fractures.



Pore scale digital rocks and cement characterization.

edx.netl.doe.gov

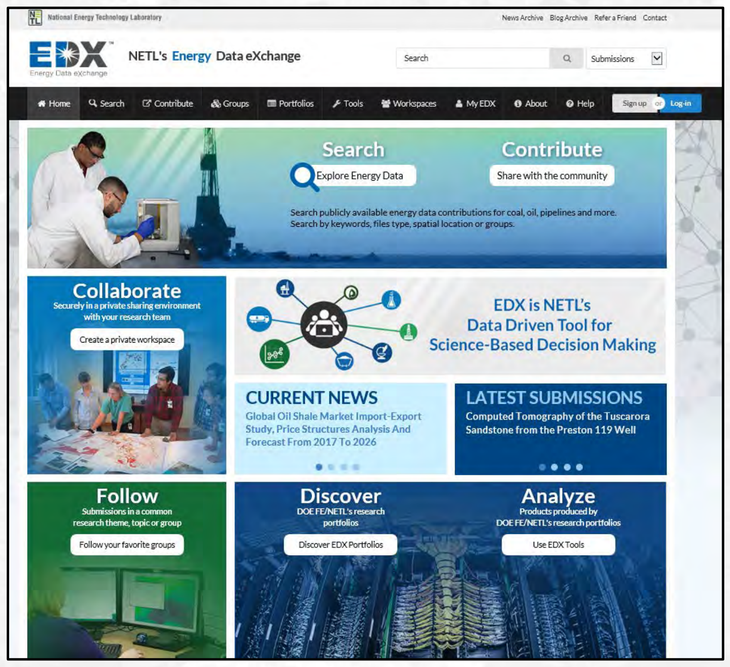
Energy Data eXchange

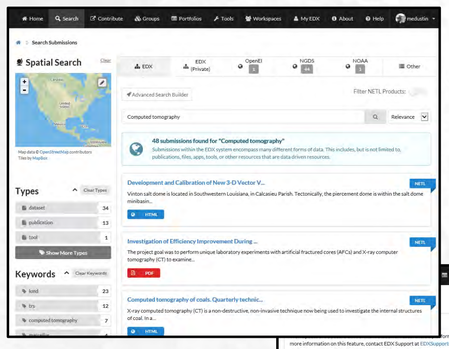
In 2011, EDX was developed for NETL/DOE R&D to facilitate data transfer, enhance collaboration in secure workspaces, and curate data from disparate sources.
- A technical R&D tool built by researchers for researchers
- An online platform for rapid and efficient access to priority submissions
- Provide enduring access to fossil energy products
- Share and “publish” online submissions and data-driven products
- A secure environment for multi-organizational research teams to share, build, and collaborate
- Online tool to disseminate data, information, and results from DOE’s Fossil Energy research portfolios

Enabling Data Discoverability and Citations

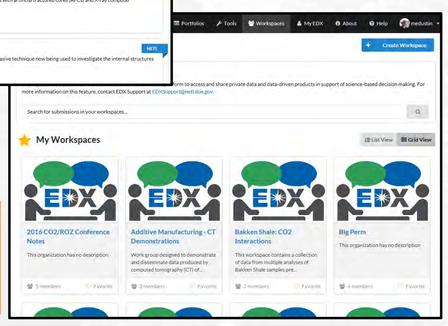
- Providing external access to technical products and data published by NETL-affiliated research teams.
- Collaborating with a variety of organizations and institutions in a secure environment through EDX’s Collaborative Workspaces.
- Coordinating historical and current data and information from a wide variety of sources to facilitate access to research that crosscuts multiple NETL projects/programs .

Wide Variety of Datasets, Simulation and Experimental





Data archived and searchable from numerous NETL and non-NETL related projects.



Workspaces provide collaboration across institutions in a secure environment.

References

Masa Prodanovic, Maria Esteva, Matthew Hanlon, Gaurav Nanda, Prateek Agarwal (2015) Digital Rocks Portal: a repository for porous media images http://dx.doi.org/10.17612/P7CC7K

Kelly Rose et al (2018) EDX: NETL’S DATA DRIVEN TOOL FOR SCEINCE-BASED DECISION MAKING, NETL Factsheet 184, edx.netl.doe.gov/wiki/images/3/33/R-D184_2017-10-11.pdf

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