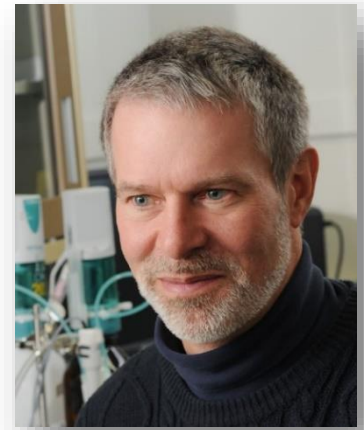


# "The Story of Earth: How Life and Minerals Co-Evolved"

By Robert M. Hazen

We are pleased to announce several upcoming free public events at the Colorado School of Mines with Dr. Robert M. Hazen, Senior Staff Scientist at the Geophysical Laboratory Carnegie Institution, Washington, D.C.; Clarence Robinson Professor of Earth Sciences at George Mason University, Fairfax, Virginia; Executive Director of the Deep Carbon Observatory.



Dr. Robert M. Hazen

## Lecture 1, Wednesday, April 25, 2018, 7:00 pm: "Mineral Evolution and Ecology: Tracing Earth's History Through Time and Space"

- Berthoud Hall, Room 241, Colorado School of Mines, Golden. (Seating is limited; please pre-register at <http://bit.ly/2HO5mLZ>.)

**ABSTRACT:** A fundamental challenge in geology is to understand the evolving diversity and distribution of rocks and minerals through more than 4 billion years of Earth history--changes that reveal much about our planet's co-evolving geosphere and biosphere. Mineral evolution and mineral ecology, which explore mineral occurrences through time and space, exploit large and growing data resources to detect previously hidden patterns in nature. We find dramatic changes in Earth's mineralogy as a consequence of physical, chemical, and most surprisingly biological processes. Powerful analytical and visualization methods are now allowing us to predict Earth's "missing" minerals--a prelude to the discovery of new ore deposits and other natural resources.



Image 1: The formation of the Earth 4.55 billion years ago.



Image 2: "Black Earth" – volcanoes pour basalt across the land 4.4 billion years ago.



Image 3: "Red Earth"- the innovation of oxygen-producing photosynthesis about 2.5 billion years ago changed Earth, turning the land red and ultimately resulting in more than 2/3 of all known mineral species.

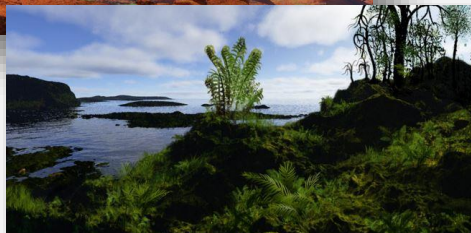


Image 4: "Green Earth" – life began to populate land about 450 million years ago, leading to what we think of as the living earth.

## Lecture 2, Thursday, April 26, 2018, 7:00 pm: "Big-Data Geology: Visualizing Earth's Co-Evolving Geosphere and Biosphere"

- Berthoud Hall, Room 241, Colorado School of Mines, Golden. (Seating is limited; please pre-register at <http://bit.ly/2pmpGcS>.)

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**ABSTRACT:** The distribution of minerals, rocks, and fossils on Earth mimics social networks, as commonly applied to such varied topics as Facebook interactions, the spread of disease, and terrorism networks. Applying network analysis to these natural objects provides a powerful visual approach to understanding the diversity and distribution of species, while revealing patterns that help predict "missing" deposits. These patterns provide new insights into the way planets evolve, especially the co-evolving geosphere and biosphere, while comparisons of networks for Earth materials with those of Mars and other worlds hint at why Earth is unique.

### **Book Discussion, Thursday, April 26, 2018, 12:00 pm -1:30 pm – “The Story of Earth: The First 4.5 Billion Years, from Stardust to Living Planet”**

- Boettcher Room, Arthur Lakes Library, Colorado School of Mines, Golden. (Lunch will be provided but seating is limited; please RSVP to [gevans@mines.edu](mailto:gevans@mines.edu).)
- Dr. Hazen will lead a discussion of his book, The Story of Earth. Participants are expected to have read the book--available at [www.amazon.com](http://www.amazon.com).

**SPEAKER INFORMATION:** Dr. Robert M. Hazen, Senior Staff Scientist at the Carnegie Institution’s Geophysical Laboratory and Clarence Robinson Professor of Earth Sciences at George Mason University, received the B.S. and S.M. in geology at the Massachusetts Institute of Technology, and the Ph.D. at Harvard University in earth science. He is author of 400 scientific articles and 25 books, including *Genesis: The Scientific Quest for Life’s Origin* and *The Story of Earth*. He was the 2016 Roebling Medalist and a former President of the Mineralogical Society of America. Hazen’s recent research focuses on the role of minerals in the origin of life, the co-evolution of the geo- and biospheres, and the application of “big data” to understanding mineral diversity and distribution. He is also Executive Director of the Deep Carbon Observatory, a 10-year project to study the chemical and biological roles of carbon in Earth’s interior. Hazen is active in presenting science to nonscientists through writing, radio, TV, public lectures, and video courses. In 2016 Hazen retired after a 45-year career as a professional symphonic trumpeter.

- Dr. Hazen's personal web site: <http://hazen.gl.ciw.edu>
- DCO website: [deepcarbon.net](http://deepcarbon.net)
- 4-D Workshop website: [www.4d-workshop.net](http://www.4d-workshop.net)
- Keck Deep-Time Project website: <http://dti.carnegiescience.edu>

A related technical seminar and two workshops with Dr. Hazen's research colleagues will also take place on Wednesday and Thursday, April 25-26, 2018. Interested members of the public are welcome to attend these events:

### **Seminar, Wednesday, April 25, 2018, 11:00 am - 12:00 pm - "Mineral Network Analysis: Big Data as Applied to Mineral Systems"**

- Berthoud Hall, Room 241, Colorado School of Mines, Golden.
- Presenters: Dr. Shaunna Morrison, Carnegie Institute, Washington, D.C.; Ahmed Eleish and Anirudh Prabhu, Rensselaer Polytechnic Institute, Troy, NY.

**ABSTRACT:** Advanced analytics and visualization has revolutionized nearly all aspects of our society, from city infrastructure to advertising and from healthcare to our understanding of the cosmos. Growing databases in mineralogy and geochemistry offer the opportunity to apply big data techniques to prominent questions in geology and planetary science. These techniques, such as network analysis, allow exploration of multidimensional trends in complex mineralogical systems. For example, mineral network studies have revealed embedded chemical and temporal axes as well as clustering by composition or paragenetic mode.

### **Technical Workshop: “Mineral Network Analysis I”, Wednesday, April 25, 1:00 pm - 4:00 pm**

- Berthoud Hall, Room 306, Colorado School of Mines, Golden.

### **Technical Workshop: “Mineral Network Analysis II”, Thursday, April 26, 8:00 am -11:00 am**

- Marquez Hall, Room 322, Colorado School of Mines, Golden.
- Workshop seating is limited; please pre-register at [rwendlan@mines.edu](mailto:rwendlan@mines.edu)

**These events are made possible with generous financial assistance of the Friends of the Colorado School of Mines Geology Museum (FCSMGM), the Colorado School of Mines Arthur Lakes Library, the Colorado School of Mines Department of Geology and Geological Engineering, the Denver Region Exploration Geologists Society (DREGS), and the Colorado Scientific Society (CSS).**

**HOW TO FIND THE PRESENTATIONS:** Berthoud Hall is on the east side of the pedestrian mall extension that runs south from Maple Street on the Mines campus. Room 241 is the large auditorium on the 2nd floor. The closest parking is in Lot D, due west of the Ben Parker Student Center and is FREE in the evening. Paid parking is available during the day. Berthoud Hall (#7), Marquez Hall (#40), and Lot D are shown on this campus map: <http://inside.mines.edu/UserFiles/File/facilities/MinesCampusMap.pdf>

- For more information, please contact Mike Smith ([m\\_l\\_smith@earthlink.net](mailto:m_l_smith@earthlink.net); 303.530.2646)