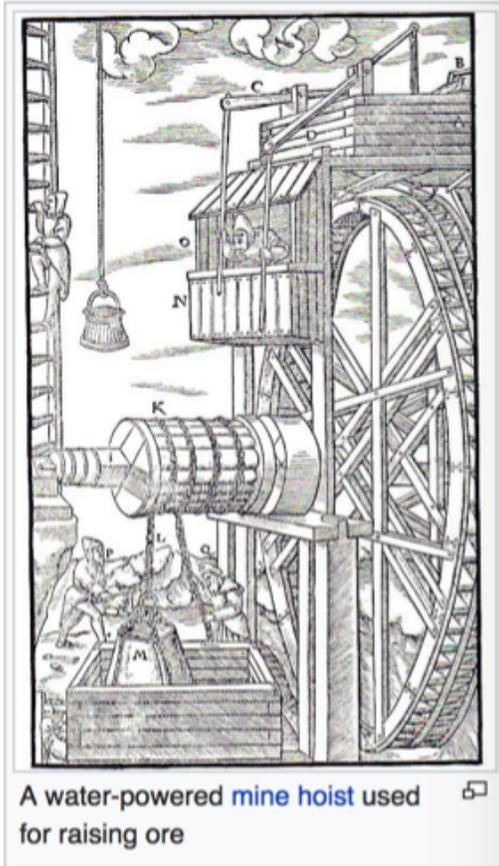


Stanford University Symposium on Mineral Resources and Their Sustainable Development

December 8-9, 2017

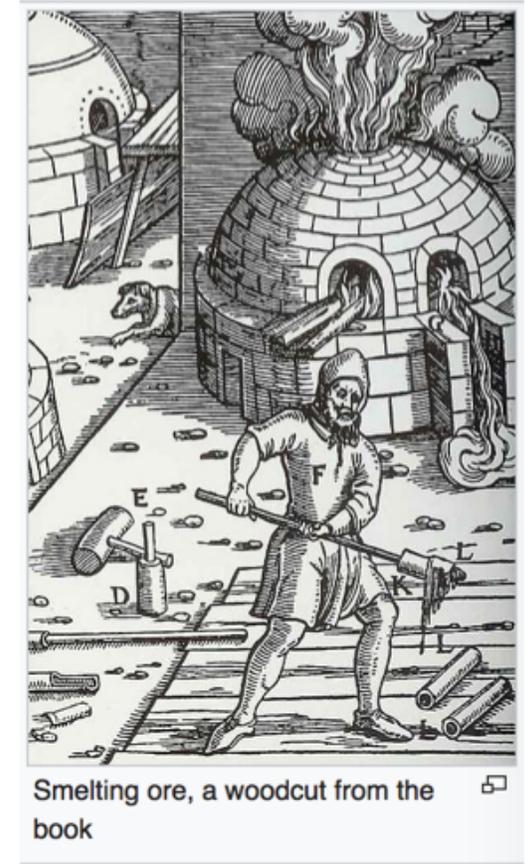


A water-powered mine hoist used for raising ore

De Re Metallica (1556)



<http://www.city-data.com/articles/Kennecotts-Bingham-Canyon-Copper-Mine.html>



Smelting ore, a woodcut from the book

De Re Metallica (1556)

Elements

An International Magazine of Mineralogy, Geochemistry, and Petrology

October 2017
Volume 13, Number 5

ISSN 1811-5209

Mineral Resources and Sustainability

GEORGES CALAS, Guest Editor

Resources and Sustainable Development

Beneficiation and Mineral Engineering Opportunities

Sourcing Critical Metals

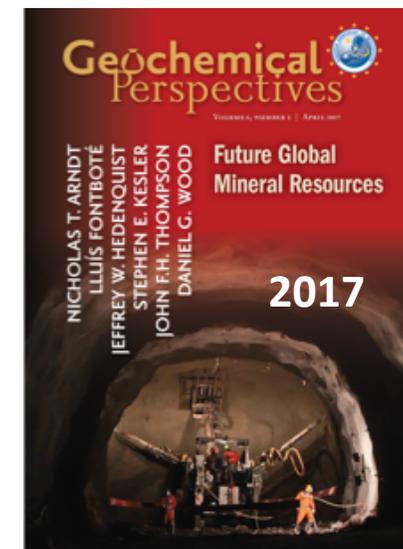
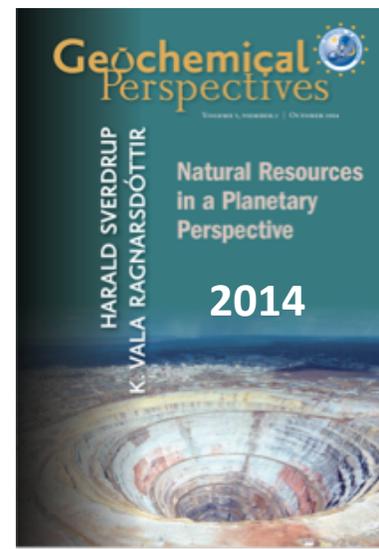
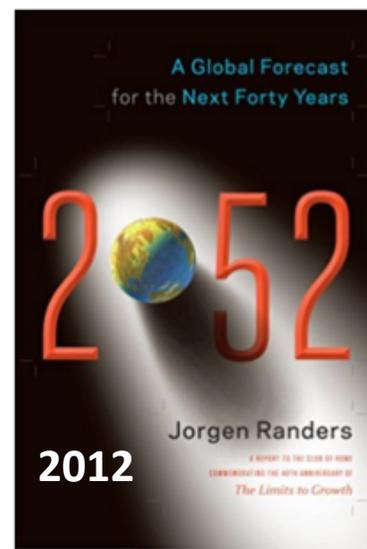
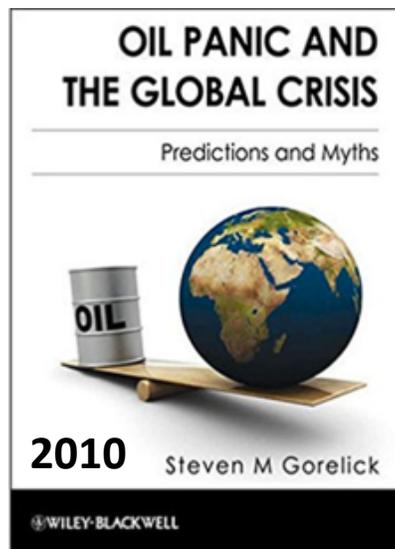
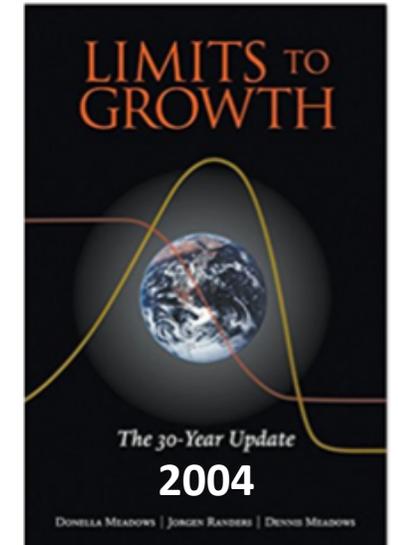
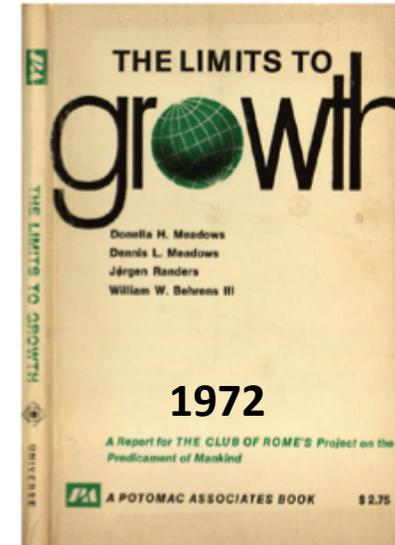
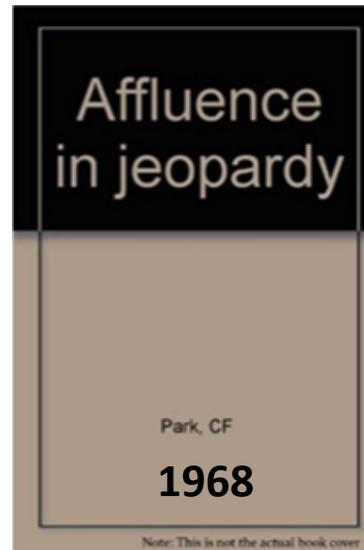
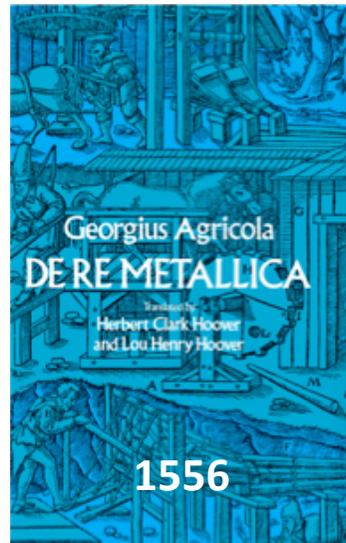
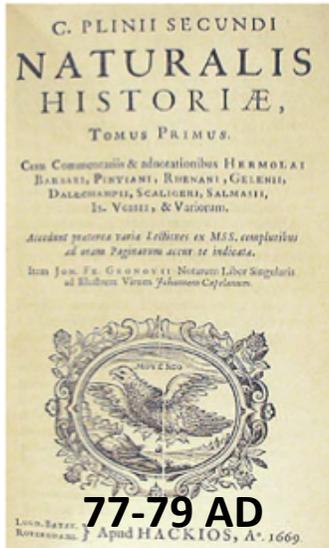
Global Resources Supply and Consumption

Improving Mitigation of Mining Contamination

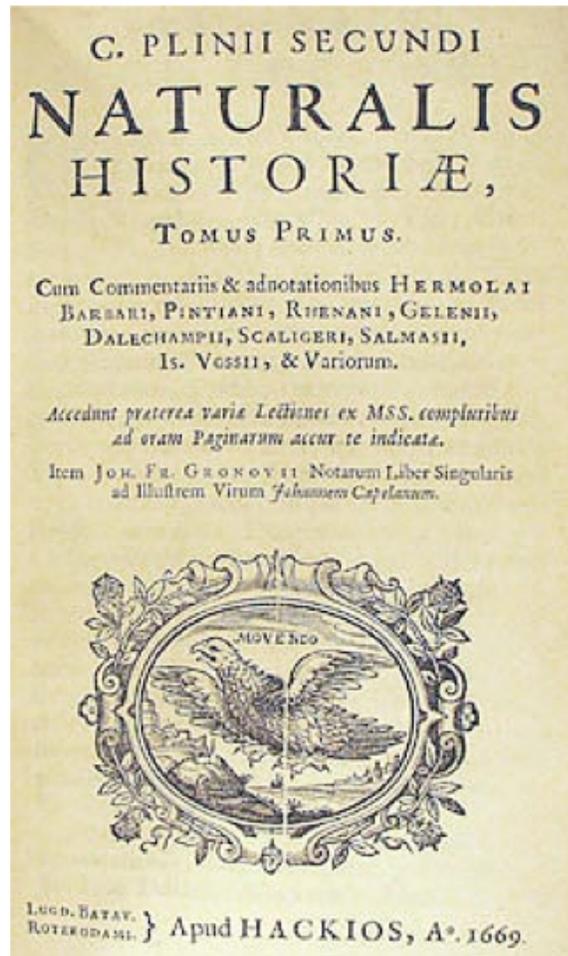
Educating Future Resource Geologists



Some Books on Earth's Nonrenewable Resources



Pliny the Elders *Natural History* (77-79AD)

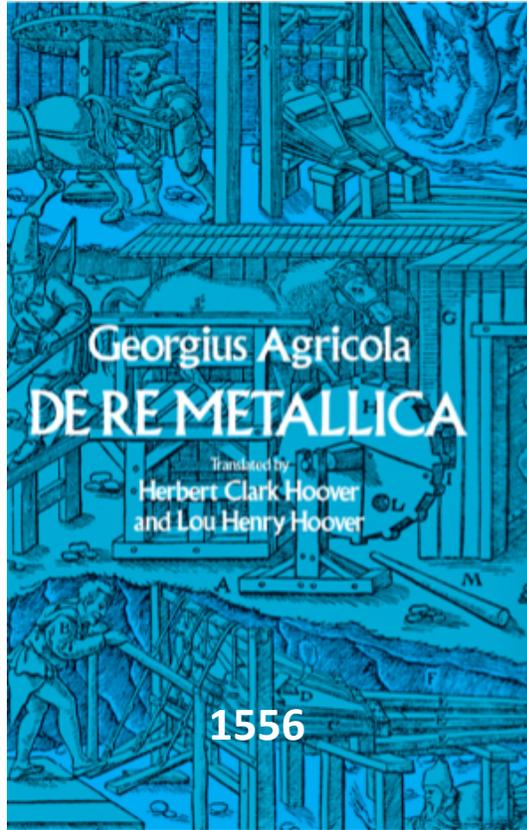


Pliny's *Natural History* consists of 37 books in 10 volumes and covers a large range of topics, including Metallurgy, Mining, and Mineralogy.

Pliny provides detailed descriptions of [Roman mining](#), including [gold mining](#), pointing out the large-scale use of water to scour alluvial gold deposits. Pliny was scathing about the search for precious metals and gemstones: "*Gangadia* (or [quartzite](#)) is considered the hardest of all things – except for the greed for gold, which is even more stubborn."

Georg Bauer (aka Georgius Agricola) *De Re Metallica* (1556)

- Translated in 1912 from the Latin to English by Herbert and Lou Henry Hoover
- Herbert Hoover was awarded a degree in Geology in the first graduating class at Stanford University in 1895, worked as a mining engineer after graduation, and eventually became the 31st President of the United States in 1929.
- The arguments presented by Agricola range from philosophical objections to gold and silver as being intrinsically worthless, to the danger of mining to its workers and its destruction of the areas in which it is carried out. Agricola argues that *“without metals, no other activity such as architecture or agriculture are possible”*. He dismissed the dangers to miners, noting that *“most deaths and injuries are caused by carelessness, and other occupations are hazardous too”*. *“Clearing woods for fuel is advantageous as the land can be farmed. Mines tend to be in mountains and gloomy valleys with little economic value. The loss of food from the forests destroyed can be replaced by purchase from profits, and metals have been placed underground by God and man is right to extract and use them.”* Finally, Agricola argues that *“mining is an honorable and profitable occupation”*.

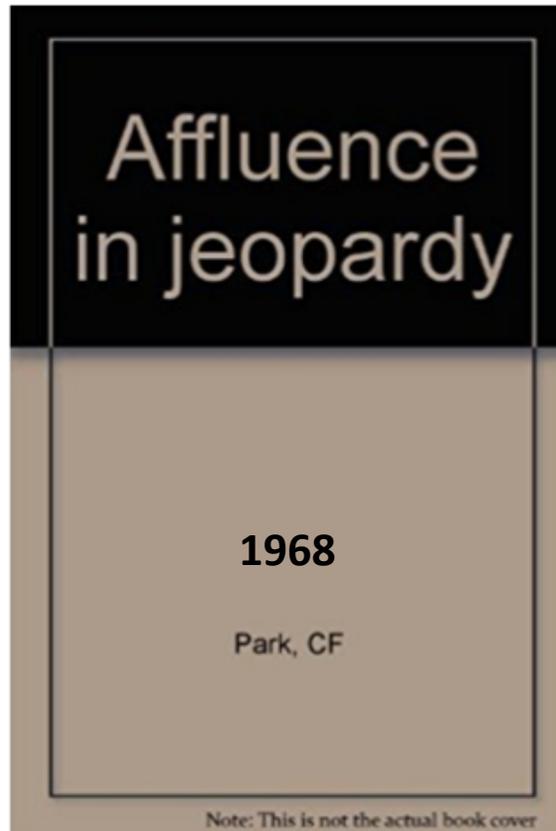


First Graduating Class in Geology at Stanford University

May 29, 1895



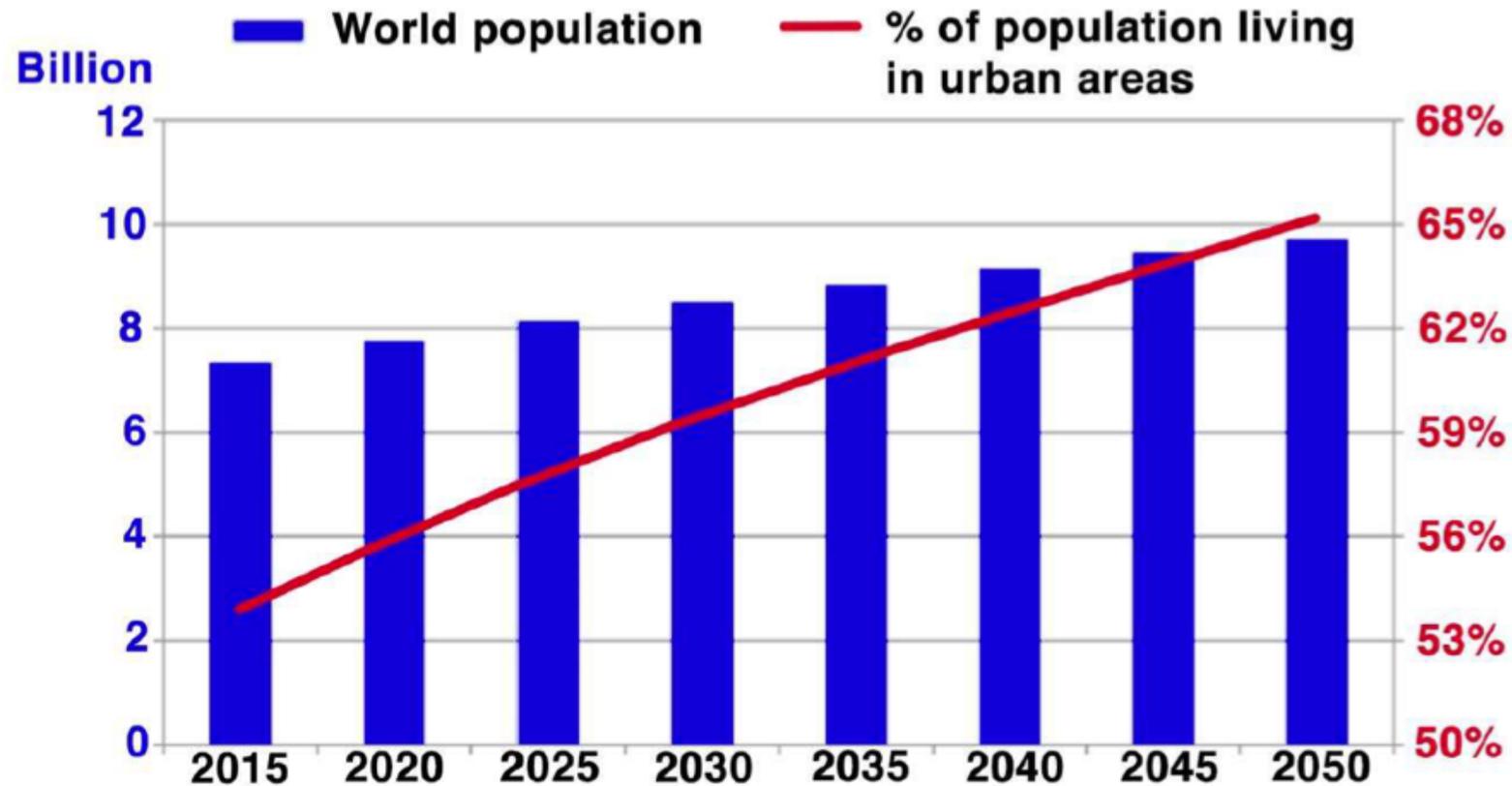
Charles F. Park, Jr. – *Affluence in Jeopardy* (1968)



- **Dr. Charles F. Park, Jr.** was Dean of the School of Mineral Sciences (now Earth, Energy & Environmental Sciences) at Stanford University from 1946-1964. He published *Affluence in Jeopardy* in 1968.

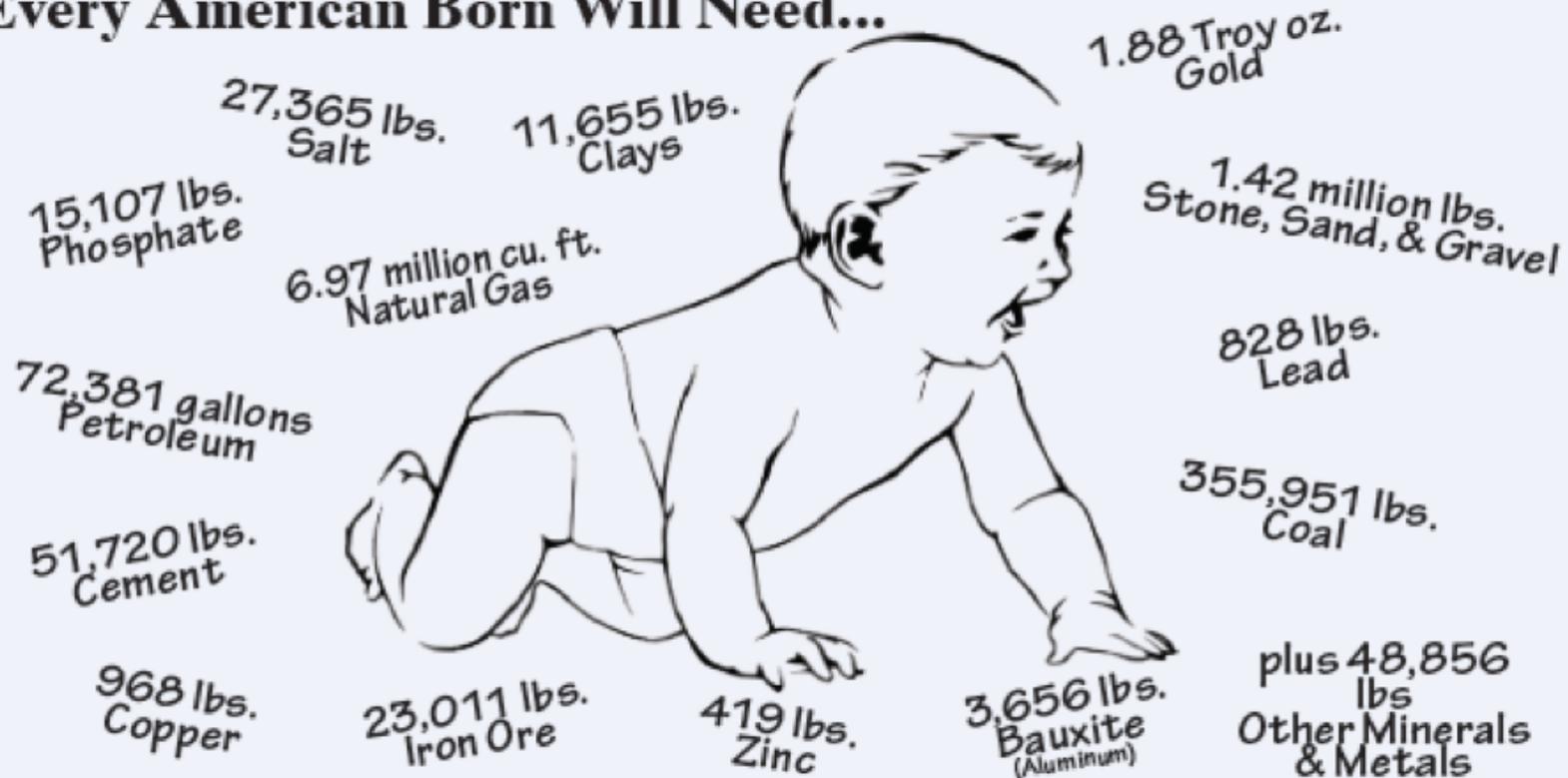
- Quoting from *Affluence in Jeopardy*: “Citizens of the United States are told that we have an affluent society. We are also told that hope for peace in the world depends on our extending over the world our philosophy and technology of affluence. But, a single physical factor may prevent the building of any worldwide affluent society. The doctrine of affluence is based upon the assumption that this earth’s mineral supplies (or substitutes for them) are adequate for universal affluence. Are they? Can the earth afford the world’s affluence? Can it even continue to afford the affluence that exists today?”

United Nations World Population Projections



Natural Resources Consumption in the US

Every American Born Will Need...

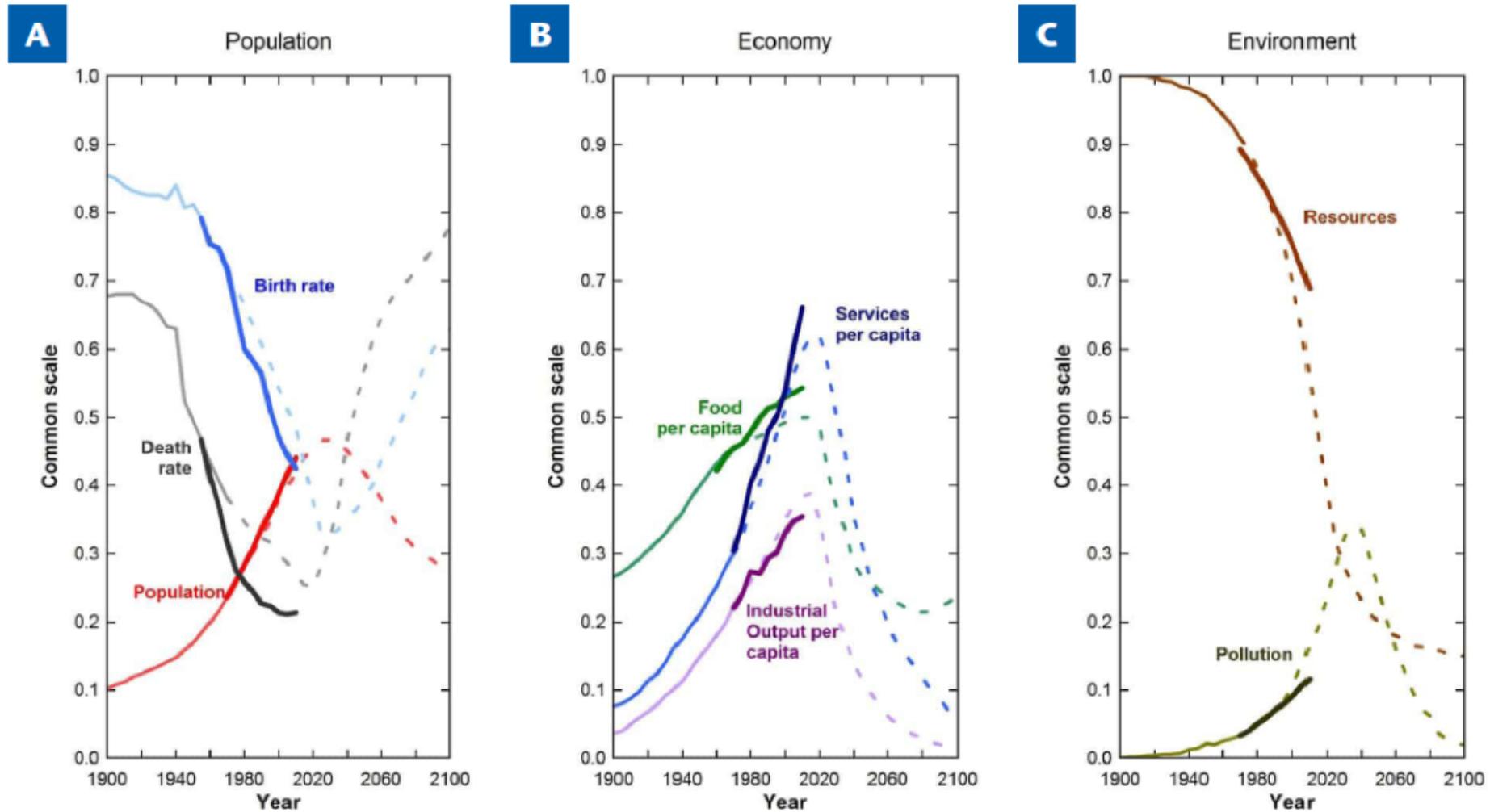


3.188 million pounds of minerals, metals, and fuels in their lifetime

©2017 Minerals Education Coalition

Learn more at www.MineralsEducationCoalition.org

Projections of the Standard Model in *The Limits to Growth* to 2100 for (A) Population, (B) Economy, and (C) Natural Resources



In the standard model, the global system collapses because of resource depletion, which leads to increased diversion of industrial capital into resource extraction, which, in turn, reduces industrial growth. The global population continues to rise for a while and then declines as death rates increase due to lack of food and health services (Woods (2017) *Elements Magazine*).

Stanford University Symposium on Mineral Resources and Their Sustainable Development

December 8-9, 2017

The purposes of this symposium are to assess

- (1) the current and future reserves of key mineral resources, particularly the class of mineral resources referred to as critical materials;
- (2) the rates at which mineral resources are being depleted and new resources are being discovered;
- (3) the environmental impacts of development and utilization of mineral resources;
- (4) the economic and social impacts of mining and mineral resource utilization, particularly in developing countries; and
- (5) the scientific and technological advances needed to identify, extract, and beneficiate mineral resources in cost-effective and efficient ways, including the re-use of materials derived from minerals, while improving the quality of the final products and minimizing environmental impacts.

Stanford University Symposium on Mineral Resources and Their Sustainable Development

December 8-9, 2017

Organizing Committee

Dr. Gordon E. Brown, Jr.: D.W. Kirby Professor of Geological Sciences, School of Earth, Energy & Environmental Sciences, Stanford University, Stanford, CA 94305-2115, USA, and Professor of Photon Science, SLAC National Accelerator Laboratory, Menlo Park, CA 94062, USA (gordon.brown@stanford.edu)

Dr. Georges Calas: University Institute of France Chair of Mineralogy, Institut de Minéralogie, Physique des Matériaux et Cosmochimie, Université Pierre et Marie Curie (UPMC)-Paris VI, CNRS, Case 115, 4 Place Jussieu F-75252 Paris Cedex 05, FRANCE (georges.calas@upmc.fr)

Mr. Bradford A. Mills: Managing Director, Plinian Capital, 88 Chester Sq. London SW1W 9HJ, U.K. (b.mills@pliniancapital.com)

Ms. Julie Hitchcock: Administrative Associate, Department of Geological Sciences, Stanford University, 450 Serra Mall, Building 320, Rm. 122, Stanford, CA, 94305-2115, USA (julieh1@stanford.edu) (650-724-8437)

Ms. Barbara Buell: Chief Communications Officer, School of Earth, Energy & Environmental Sciences, Stanford University

Dr. Stephan A. Graham: Dean, School of Earth, Energy & Environmental Sciences, Stanford University

Dr. Jonathan Payne: Chair, Department of Geological Sciences, Stanford University

Welcome to Stanford University





Coal Mines at the source of the Yellow River, China



Wires and cables brought to the Lyari River, Karachi, to be burned.