

The Importance of Critical Materials to Innovation

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- In 2018 the USGS published an alphabetical list of the metals and minerals chosen as the most critical for the health of the U.S. economy.
- It is important to prioritize that list to determine which critical materials are those without which the U.S. economy could not function.
- The easiest way to prioritize that list is to first look at the USGS chart of U.S. Import Reliance of metals and minerals, and the most important of those materials are the ones for which the U.S. is (now) 100% dependent on imports. These materials represent both those that are cheaper to import than to produce domestically and those that are scarce but have recently become important as enablers of technology.

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- 100% Import Dependent
 - ARSENIC (all forms)
ASBESTOS
CESIUM
FLUORSPAR
GALLIUM
GRAPHITE (natural)
INDIUM
MANGANESE
MICA, sheet (natural)
NEPHELINE SYENITE
NIOBIUM (columbium)
RARE EARTHS (compounds and metal)
 - RUBIDIUM
 - SCANDIUM
STRONTIUM
TANTALUM
YTTRIUM
 - The U.S imports 35% of its needs annually for refined copper even though very large amounts of copper are produced within the USA, because we no longer have the capacity to refine copper from its ores in the amounts we use.
 - The U.S. imports only 25% of the lithium its industries use today only because domestic American industry uses very little lithium.
- Major Sources of Initial Production
- China, Morocco
 - Brazil, Russia
 - Canada (Mine owned by China)
 - Mexico, China
 - China, Ukraine
 - China
 - China, Canada
 - South Africa, Gabon, Australia
 - China, Brazil
 - Canada
 - Brazil
 - China
- Canada
- Russia, China, Kazakhstan
 - Mexico, China
 - Brazil, DRC (Congo), Rwanda
 - China

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- Prior to World War II resource dependent innovation was limited to mechanical and electrical devices and their needs for electric power and fuel. Iron, aluminum, and copper were the key metals and coal and oil were the fuels. All were produced in abundance within the USA.
- During and after the War the ages of electronics and nuclear-electric technologies began. It is the electronic properties of certain metals and alloys that enable electronics and the nuclear makeup of just a very few metals that enable controlled fission.
- **The United States today is not self sufficient in any one of these critical technology metals!**

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- During the foundation period of electronics and nuclear electricity (1944-1970) production all necessary metals and materials were mined, refined, and fabricated domestically in the USA.
- Then, as now, both academic and industrial research paid no attention to the availability of any technology metal or material. It was always assumed that the free market would solve any supply problem.
- This error continues and continues to stiffen commercial innovation.
- Until it is standard practice to determine whether or not the necessary supply of a critical metal or material is economically available PRIOR to attempting to implement innovation in the processing or utilization of a metal or material it is of little value to pursue such innovation. China recognized this impediment to technological progress a generation ago and adopted an industrial policy designed to enable the widespread adoption of modern electronic and nuclear technologies. It's time for America to adopt the same policy of securing sources of critical metals and materials.