New Method to Compute the Emergy of Crustal Minerals

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ABSTRACT

To date, Unit Emergy Values (UEVs) for crustal minerals (e.g., limestone, iron ore, etc.) have lacked thermodynamic basis and suffer from overly vague generalization (relative to most other, more certain emergy indicators). We assume a steady state crustal cycle that embodies the various forms of exergy supporting Earth system cycles. The UEV of average crust is $1.75 \times 10^9$ solar emergy joules per gram (specific emergy). The ratio of crustal specific emergy to a mineral’s exergy density (exergy per mass) is the mineral’s transformity. This is an important assertion as it is the dissipation of exergy which hierarchically organizes materials. Emergy accounting should be able to express every resource either a transformity or specific emergy, linked by exergy density: crustal minerals are no exception.

Mineral transformity can be characterized using either chemical exergy or Gibb’s formation energy. Both calculations use the same mixing term which depends on average crustal abundance of the mineral. Also it’s possible to account mineral emergy using either total free energy (or total chemical exergy) or by accounting only the mixing exergy. Four herein proposed methods yield a wide range of specific emergies for each of the prominent mineral/metal inputs to economies. We conclude that the exergy of concentration (mixing exergy) best represents that which is destroyed in mining/extraction activities and that using Gibb’s transformities better suit the emergy method due to chemical exergies being positive or negative depending on the mineral. The emergy accounting of minerals should utilize Gibb’s transformities and account only the emergy of a mineral’s mixing exergy because this represents the natural capital that is irrevocably destroyed in mineral harvesting.

Citation
