Mystery:
Formation of Mineral Deposits in Earth
and
Big Bang

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I was always mystified: how come that at some places in earth we have gold deposits, in others – iron, in others – cupper, in others, even more mysteriously, diamonds which is not a chemical element! How the tiny atoms of gold find other tiny atoms of gold? Or atoms of iron find iron… We have seven main theories of formation of such deposits. In my mind, there is something wrong if to explain a single phenomenon, admittedly fairly complex, you need not one or two but SEVEN different theories! Here are those theories (thank you AI, my new friend!).

BACKGROUND: THEORIES OF FORMATION OF ELEMENTAL MINERAL RESOURCES IN EARTH

1. Magmatic Differentiation (Iron, Copper, Platinum)

Magmatic differentiation is a process where molten rock (magma) cools and crystallizes into various minerals at different temperatures. During this process, certain elements may become concentrated in the remaining melt or in specific mineral phases. This can lead to the formation of deposits of native elements, such as:

- **Iron**: Iron-rich minerals may form through magmatic differentiation, especially in ultramafic rocks. The remaining melt, which is rich in iron, can crystallize as magnetite (Fe_3O_4) or hematite (Fe_2O_3), leading to iron ore deposits.
- **Copper and Platinum**: Native copper and platinum can form in layered mafic and ultramafic intrusions through this process, where the elements accumulate in the lower portions of the magma chamber.

2. Hydrothermal Processes (Gold, Silver, Copper)

Hydrothermal processes involve the circulation of hot, mineral-rich water through cracks and fractures in the Earth's crust. As the hot water interacts with surrounding rocks, it dissolves elements, which are later deposited as native metals when the water cools or reacts with other rocks. This is a common formation process for:

- **Gold**: Gold can be transported in solution as complexes (e.g., gold chloride) in hydrothermal fluids. When the conditions change, such as a drop in temperature or pressure, or a chemical reaction with the host rock, the gold precipitates out as native gold.
- **Silver and Copper**: Similar to gold, silver and copper can also form through hydrothermal processes, where these metals precipitate out of solution in cracks and veins as the fluid cools.

3. Supergene Enrichment (Gold, Silver, Copper)

Supergene enrichment occurs near the Earth's surface, where weathering processes lead to the concentration of certain metals. Water percolating through the ground can leach metals from the upper layers and redeposit them at greater depths, concentrating them into rich, often high-grade ore deposits.

- **Gold and Silver**: In oxidizing environments, native gold and silver may be enriched near the surface through the removal of other elements like sulfur and iron, leaving behind concentrated metallic resources.

4. Metamorphic Processes (Graphite, Gold)

During metamorphism, rocks are subjected to intense heat and pressure, which can cause recrystallization and the concentration of elements.

- **Graphite**: The transformation of organic carbon through high-pressure, high-temperature conditions can result in the formation of graphite, a native form of carbon.
- **Gold**: Gold can also be concentrated in certain metamorphic rocks, such as those in greenstone belts, where pressure and heat cause fluids to move and concentrate gold in quartz veins.

5. Sedimentary Processes (Iron, Gold)

Certain native elements can also form through sedimentary processes, where they are deposited by the action of water or wind. These processes include:

- **Iron**: Banded iron formations (BIFs) are a key example of sedimentary iron ore deposits. They formed billions of years ago in oceans where dissolved iron precipitated out of seawater, forming alternating layers of iron-rich minerals and chert (silica).
- **Gold**: Placer deposits form through sedimentary processes where gold, which is dense and resistant to weathering, accumulates in riverbeds and beaches after being eroded from primary sources.

6. Volcanogenic Processes (Iron, Sulfur)

Volcanogenic processes involve the direct deposition of minerals from volcanic gases and fluids.

- **Iron**: Some iron deposits, particularly those associated with massive sulfide deposits, are formed from hydrothermal fluids expelled from volcanic activity on the seafloor (volcanogenic massive sulfide deposits).
- **Sulfur**: Native sulfur can form from volcanic gases, particularly in regions around fumaroles where sulfur-rich gases cool and deposit sulfur directly on the surface.

7. Crustal Differentiation and Earth's Early Formation (Native Metals)

Some native element deposits are believed to have originated early in Earth's history, when the planet's crust was still differentiating and cooling.

- **Iron and Nickel**: In Earth's early molten state, dense metals like iron and nickel settled into the core, but some remained in the crust and mantle. Over billions of years, tectonic processes and volcanic activity have brought these metals closer to the surface, forming the basis for later mineralization processes.

THEORY: BIG BANG AND GEOLOGICAL DEPOSITS

My “holistic” approach to nature, including the entirety of all sciences tells me that in such a case there might be a single unifying theory, with 7 standing theories covering some nuances.

One observation shifted my thinking from earth-based theories to a cosmological origin of mineral deposits. The trigger to this thinking were meteorites. Specifically, meteorites made of a ‘pure” allow of nickel and iron coming from outer space were observed. Go and explain those meteorites using any or all of those seven theories! And so, my search began…

BIG BANG

Very soon I converged on the idea that all materials floating in the universe (or in our galactic, to be more modest) came from the Big Bang. ELEMENTS AND ALL! I call my theory descriptively, A Post-Big Bang Material Condensation Theory (MCT).

MATERIAL CONDENSATION THEORY

All spread around in space elemental geologic deposits or groups of chemical elements in the astronomical bodies such as asteroids and meteorites date to the time shortly after the super-hot primordial gas created by the Big Bang – a mixture of hydrogen and helium – started to cool down all the way to a point of inception of “condensation” (scientific name of the “condensation” process is Big Bang nucleosynthesis) of the that gas into the progressively heavier and heavier elements of the periodic table as the cooling continued. The Big Bang theory tells us that nuclei – bases of all atoms – started to form after about 100 seconds into Big Bang. The heavier elements were created during Stellar Nucleosynthesis inside of stars, supernovae, and other stellar processes, starting with carbon and heavier. What a kitchen!

BLOBS OF PURE ELEMENTS

The primordial Big Bang gas was crazily turbulent and non-homogeneous, meaning that its local temperatures, pressures, and densities varied widely from spot to spot. Mind you, the spots in the cosmic scale were huge, measured in light-seconds (for reference, one light second is 186,000 miles). This spatial non-homogeneity and fluctuations in the properties of that the condensation of hot gaseous matter resulted in creation of huge contiguous “blobs of matter” made of pure elements or their mixtures.

Our assumption is that production of each specific element takes place only at a particular, unique temperature-pressure-density combination of the hot matter that would “favor” formation of that particular element in that particular hundreds-of-miles long spot. Eventually, the rapid cool-down of matter became well-defined elemental blobs made of pure elements spread over space. Turbulent collisions was mixing with blobs with each other creating stars and eventually planets along with the geological mineral deposits as they kept cooling and solidifying into the “solid” matter of the universe.

METEORITES, METEORS, ASTEROIDS

This scenario nicely explains the formation of the meteorites or other cosmic bodies consisting of pure or almost pure elements. At the same time, analysis of spatial distribution of elements in meteorites and other larger astronomical bodies, starting from the solar system (stars, planets, and moons) and far beyond, may support this condensation theory of formation of multiple regions in space each filled with a pure single element that would eventually break up into smaller cosmic-sized or smaller bodies such as meteorites, meteors, or asteroids.

GEOLOGICAL ELEMENTAL MIXTURES

As a side point, it would be interesting to analyze distributions of elements with “neighboring atomic numbers” in the vicinity of known geological deposits; for example, gold and neighboring elements, mercury and neighboring elements, etc. The assumption being that the primordial gas temperature-pressure-density distribution at the time of formation of solid matter was relatively gradual and thus, the elements-neighbors in the periodic table would become the neighbors in the geological deposits.

Note that our condensation theory applies primarily to the elemental, not complex mineral deposits in the Earth. The latter were perhaps formed much later via concentrating and transporting agents, precipitating processes such as boiling, cooling of hot solutions, crystallization of magma, chemical reactions – all those processes that make the seven theories mentioned earlier: http://www.britannica.com/EBchecked/topic/383726/mineral-deposit/82171/Formation-of-mineral-deposits

GOLDEN RAIN FROM BIG BANG

Allowing some wild imagination, somewhere in deep space there might be a meteorite made of pure gold on a trajectory to Earth… When that shiny meteorite (small enough not to be an existential threat) finally enters our atmosphere and starts melting, those of us lucky to be in the right place at the right time will be showered by golden rain!