
# Magnetic fields as measured by Swarm as fingerprints of processes in the terrestrial lithosphere

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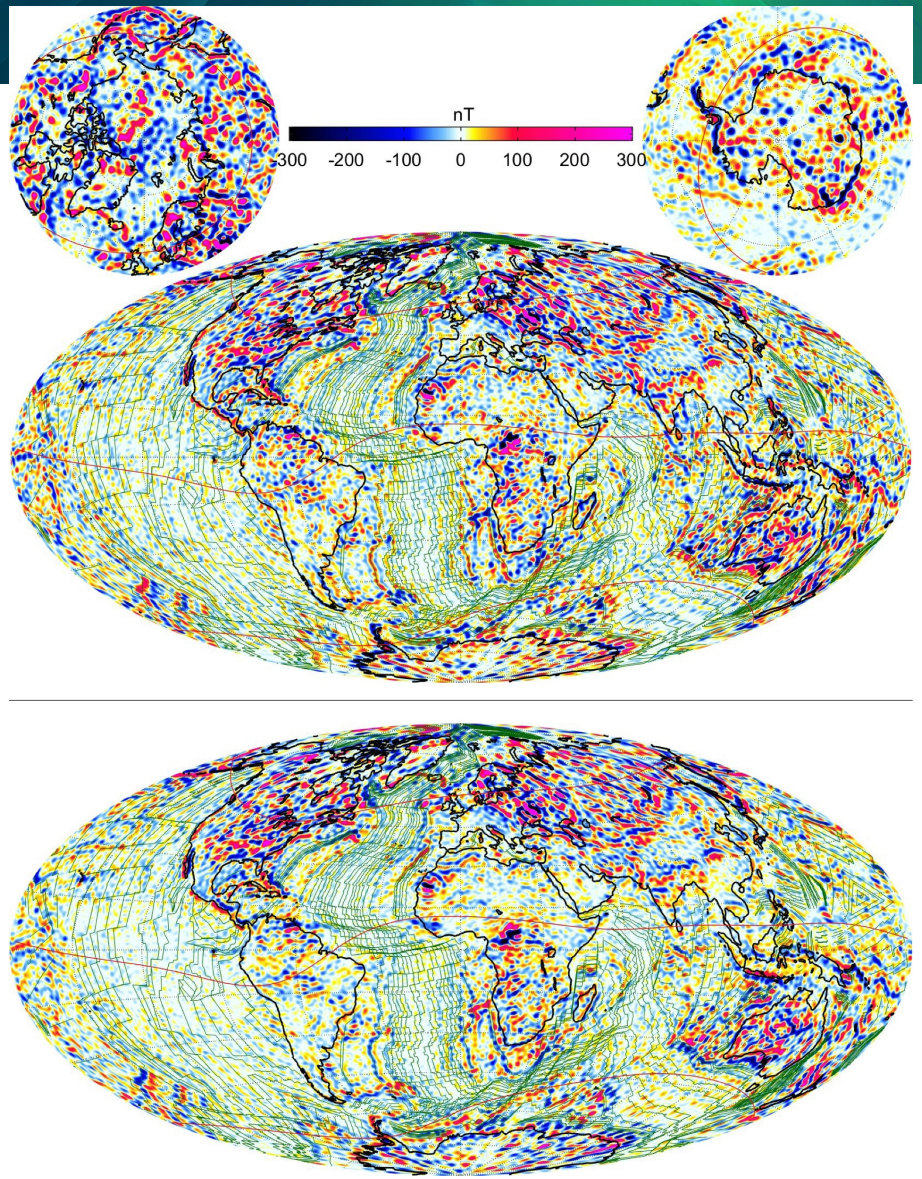
LCS-1 Magnetic field model Made using CHAMP & Swarm magnetic field gradients. Calculated at Earth's surface (ellipsoid) using degrees 16-185. Z component (top) & Scalar anomaly (bottom). Red curves are QD latitudes, Green curves are oceanic isochrons.
Olsen, Ravat, Finlay, Kother (2017), Geophy. Jour. Int.




Starting Point for this talk is LCS-1

Alternative starting point (not used): Inclusion of aeromagnetic or marine magnetic data

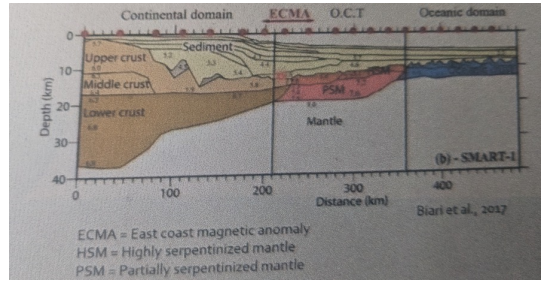
## Take-Aways

| **Processes :** | **Pointers (Refs, features, people & ideas)** |
|---|---|
| Subduction/Serpentinization | Frey (1982), Milkov (2022), ID active geo H2 systems w scalar field changes |
| Heat Flux | Fox Maule et al (2004) Martos (Earth Science Reviews, in press) |
| Tectonics | Dyment, Hatcher. Quantitative fault offsets at Earth & Mars |
| Impact | Bangui, Chicxulub, Vredefort. ID fragments of Archean impacts w scalar |
| Basin Development | West Siberian Basin, Saudi Arabia. Proven technique for ID of sed. basins |

| **Magnitude (Largest first):** | **Possible processes** |
|---|---|
| Bangui | Impact, Tectonics, Resources |
| Kursk | Resources |
| Kentucky | S x T |
| W. African craton | S x T |
| Venezuelan shield | S x T |
| Pacific ring of fire | Subduction |
| Continent-Ocean Del T | S x T |
| Kiruna | Resources |

- Magnetic anomalies associated with subduction appeared in the earliest global satellite views  of the magnetic lithosphere from the 1970s (POGOs), followed by Magsat, Orsted, Champ & now Swarm). The East Coast Magnetic Anomaly (ECMA) is an example of a magnetic anomaly not associated with subduction, but one that relies on the same starting material (iron-rich silicates) and produces hydrogen by the same ‘rusting’ reaction. In some models (e.g. Ellis) the ECMA is the source rock for geologic hydrogen, and it may migrate updip into a reservoir from which it may be extracted. Note that the ECMA is located offshore the eastern US, extending from Georges Bank to N Florida (1000 km), but is only a 100 km wide & 20 km thick and so is not visible to Swarm.
- Process: ‘Rusting’ of iron-rich silicates, generating magnetite, serpentinite, and hydrogen
- The geologic hydrogen is a potential energy resource, but how abundant is it, what are the trapping mechanisms, and how do we concentrate it? The only place it is currently extracted, and used as an energy resource, is in war-torn Mali.
- Lithospheric magnetic fields can be used to prospect for geologic hydrogen (cf. Ellis, and Milkov before him).
- Possible ancient Mars example from magnetic anomalies associated with the northern boundary of the Utopia impact basin (3300 km diameter, 4+ Ga age)


DNAG, 1986




McCollom, Klein, Ramba, 2022, Icarus & Mittelholz, 2020