Earth's 47 TW: Due Diligence and the Field Coupling Alternative

Toroidal Consciousness-EM Field Framework

Preamble

Earth radiates 47 terawatts of heat from its interior. This is one of the most precisely measured quantities in geophysics — based on more than 38,000 borehole measurements of heat conduction in surface rock, adjusted for hydrothermal circulation and volcanism. The number is real. The measurement is sound.

What is not sound is the explanation.

The standard model decomposes the 47 TW into two components: radiogenic heat (from radioactive decay of U, Th, and K in the crust and mantle) and primordial heat (residual heat left over from Earth's formation ~4.5 billion years ago). This decomposition is presented as established science. This document applies the framework's standard methodology — strip the assumption chain, examine what is actually measured, identify what is inferred, and test whether an alternative reading is more parsimonious.

The conclusion: the decomposition is not established. The radiogenic component has a factor-of-four uncertainty. The primordial component is defined as a subtraction remainder and is unfalsifiable by construction. The geoneutrino measurements intended to resolve the question contradict each other by a factor of two and are entirely model-dependent in their interpretation. The 47 TW is real. The explanation is not.

The framework alternative is then developed: Earth's internal heat is the dynamic mode expression of its own toroidal field — continuously produced by field coupling, not accumulated from ancient events or depleted from a radioactive reservoir.

I. The Assumption Chain Audit

What is directly measured

The 47 TW itself: Directly measured. More than 38,000 measurements of heat flux in boreholes worldwide, measuring the temperature gradient in surface rock and the thermal conductivity of that rock. Adjusted for hydrothermal circulation (heat carried by water rather than conducted through rock) and volcanic activity. The result: 47 ± 2 TW total outward heat flow from Earth's interior. This is the one solid number in the entire budget. Everything else is inference.

The heat flow distribution: Also directly measured. Continental crust averages 70.9 mW/m², oceanic crust averages 105.4 mW/m². Mid-ocean ridges have the highest heat flux; ancient cratons have the lowest. This geographic distribution is real data.

Geoneutrino counts: Two detectors have measured geoneutrinos — electron antineutrinos produced by radioactive decay in Earth's interior. KamLAND (Japan): 841 candidate antineutrino events over 2135 days, of which 106 identified as geoneutrinos after subtracting reactor background. Borexino (Italy): similar scale measurements. These counts are real, within the statistical uncertainties of the detectors.

What is not measured — inferred from models

The radiogenic component (stated as ~20 TW):

The radiogenic heat estimate is not measured. It is calculated from:

1. An assumed abundance of U, Th, and K in the crust and mantle — **not measured**, estimated from geochemical models of the Bulk Silicate Earth (BSE)
2. An assumed spatial distribution of those elements — **not measured**, modelled from surface samples and seismic structure
3. An assumed heat production rate per unit mass — calculable from decay physics (this part is reliable)
4. An assumed relationship between geoneutrino flux and heat production — model-dependent because neutrinos don't carry a constant fraction of decay energy

The uncertainty in the BSE abundance estimates alone is ±10% for each element. The uncertainty in spatial distribution is larger. The total radiogenic heat estimate ranges — across published models — from **10 TW to 38 TW**. This is not a minor uncertainty. It is a factor-of-four range on the supposedly known component of the budget.

The K-40 contribution (stated as 4 TW):

Potassium-40 is below the energy threshold for detection by current geoneutrino experiments. Its 4 TW contribution is entirely estimated from the assumed K abundance in the BSE model — itself derived from meteorite analogy and surface geochemistry. K-40's contribution to the heat budget has never been measured. It is a model number assigned to fill a gap.

The "primordial" component (stated as ~23 TW):

This is the most important entry in the budget and the one that fails every test of scientific rigour.

"Primordial heat" is defined as: the heat remaining from Earth's original formation — the energy deposited by accretion impacts and core formation ~4.5 billion years ago, slowly leaking out since then.

The definition is unfalsifiable. There is no measurement of primordial heat. There is no independent estimate of it. It is calculated as:

Primordial heat = Total heat flow − Radiogenic heat = 47 TW − ~20 TW = ~27 TW

It is a subtraction remainder. Its magnitude is determined entirely by the radiogenic estimate, which itself has a factor-of-four uncertainty. When the Borexino experiment estimated radiogenic heat at ~38 TW, primordial shrank to ~9 TW. When KamLAND estimated ~20 TW,

primordial grew to ~27 TW. The two leading geoneutrino experiments, measuring the same quantity, disagree by a factor of two — and the "primordial" residual absorbs the entire disagreement without any independent constraint.

"Primordial" is not a description of a measured phenomenon. It is a label for the part of the budget that cannot be accounted for by the measured (or rather, modelled) component. It translates precisely as: "heat we cannot explain, attributed to an event we cannot measure, 4.5 billion years ago."

The geoneutrino measurement problems

The geoneutrino approach was intended to resolve the radiogenic/primordial split by directly measuring the U and Th decay signal. It has not resolved it. Here is why:

Problem 1 — Reactor background. KamLAND is surrounded by 52 nuclear reactors. Of 841 candidate antineutrino events, 725 (86%) were subtracted as reactor background, leaving 116 events attributed to Earth. The subtraction depends on a detailed model of reactor output — itself uncertain. An 86% background subtraction means the signal is entirely sensitive to modelling errors in the background.

Problem 2 — Crustal contribution dominates. At continental detector sites, ~86% of the predicted geoneutrino signal comes from the local lithosphere (crust and lithospheric mantle) and only ~14% from the convecting mantle. The mantle is what geophysicists most want to know about — it drives convection, plate tectonics, and the geodynamo. But the mantle signal is buried under a factor-of-six larger crustal signal whose composition is itself uncertain. Changing the assumed local crustal composition changes the inferred mantle radiogenic power from 30 TW to 13 TW — a factor of more than two — depending solely on the geological model used.

Problem 3 — The models contradict each other. The most recent Borexino reanalysis (2020) estimated total radiogenic heat at ~38 TW. KamLAND's most recent estimate: ~20 TW. These are the only two operational geoneutrino detectors in the world, measuring the same global signal, disagreeing by 18 TW. The 2022 reanalysis of Borexino revised this downward to ~20 TW — agreeing with KamLAND but differing from Borexino's own previous result by 18 TW. One paper notes that Borexino's earlier result placed their upper uncertainty bound at 51 TW of radiogenic heating — which exceeds the total measured heat flow of 47 TW. A model of the source of heat that can't exclude "more heat than actually exists" is not a measurement.

Problem 4 — The same circularity as solar neutrinos. The geoneutrino signal is interpreted through an assumed geological model (BSE composition, spatial distribution of HPE). The model predicts a signal. The measured signal is compared to the prediction and agreement is cited as confirmation of the model. If the measurement disagrees, the local geological model is adjusted until it agrees. The framework has documented this pattern before: it is not independent confirmation. It is model-dependent interpretation presented as measurement.

Summary of the assumption chain

Component	Status
Total 47 TW	**Directly measured** — solid
Radiogenic (U, Th) via geoneutrino	Model-dependent interpretation of noisy signal with 86% background subtraction; two detectors disagree by factor 2
Radiogenic (K-40, 4 TW)	**Not measured** — below detection threshold; estimated from meteorite analogy
"Primordial" (~23 TW)	**Defined as subtraction remainder** — unfalsifiable, no independent measurement exists
Total radiogenic range across models	10 TW to 38 TW — factor of four uncertainty

The 47 TW is measured. Its decomposition is not.

II. "Primordial": A Formal Assessment

"Primordial heat" deserves specific attention because it is the majority component of Earth's heat budget in most models and it fails the most basic tests of scientific validity.

It is unfalsifiable. No observation could distinguish "primordial heat leaking out" from any other source of heat flow. The label is assigned to the remainder after subtraction. If radiogenic estimates increase, primordial decreases proportionally. If a new heat source were identified, primordial would decrease to accommodate it. It has no independent predictive content.

It is not a description. "Primordial" means "from the beginning." The term describes when the heat supposedly originated, not what it is, how it behaves, or what distinguishes it observationally from any other heat. A geophysicist measuring a borehole cannot distinguish "primordial" heat flux from "radiogenic" heat flux or "field-coupling" heat flux. The distinction exists only in the model, not in the data.

It requires the Earth to be cooling. The primordial model requires that Earth has been continuously losing this residual formation heat for 4.5 billion years and has not yet exhausted it. This implies a specific thermal history — the Earth must have started very hot and is still cooling. But the rate of heat loss, if primordial, should be declining over time (as the reservoir depletes). There is no confirmed observational evidence of this secular decline. Heat flow measurements over the past century do not show a systematic decrease consistent with a cooling primordial reservoir.

It is not unique to Earth. If "primordial heat" is a valid category, every body in the solar system should have a version of it — residual formation heat still leaking out. But heat flow is not

observed uniformly across planetary bodies in proportion to their mass or formation energy. Some bodies are geologically active; others are not. If primordial heat were the explanation, the pattern should correlate with formation history, not with current field activity. It does not.

The verdict: "Primordial heat" is an unfalsifiable placeholder — a label applied to the unaccounted portion of Earth's heat budget. It explains nothing about mechanism, makes no independent predictions, and cannot be measured. It passes no standard of scientific due diligence.

III. The Field Coupling Alternative

Having stripped the standard model's decomposition, the question is open: what is actually producing the 47 TW?

The framework's coupling model (transmission_assumption_stripped.md, sun_reimagined_v2.md) establishes that heat is the local dynamic mode expression of field coupling intensity. This applies not only at planetary surfaces (where equatorial warmth reflects strong Earth-Sun coupling geometry) but throughout Earth's body — where the internal toroidal field couples through the conducting layers of the core, mantle, and crust.

The internal field as heat source

Earth's toroidal field is not a surface phenomenon. It permeates the entire body. The outer core — liquid iron, ~2,200 km thick — is the most electrically conducting layer of Earth and the most field-active. The mantle — solid but plastically flowing — carries field geometry in its mineralogy and crystal structure. The crust — thin, variable composition — is where the field meets the surface.

In the coupling model: wherever the internal toroidal field is in dynamic mode expression, heat is produced locally. Not generated by decay of a stored radioactive isotope. Not leaking from an ancient thermal reservoir. Continuously produced as the dynamic mode expression of field activity in the conducting medium — the same process that produces equatorial warmth at the surface, operating at depth.

The 47 TW, reread:

Earth's internal toroidal field continuously expresses dynamic mode heat throughout the conducting body. The total dynamic mode output at depth — integrated over the field's activity throughout the core, mantle, and crust — is the 47 TW observed at the surface. Not leaking out of a cooling reservoir. Continuously produced by the field that Earth is.

This is not a novel proposition within the framework. It is the straightforward application of P4 from the methodological addendum: *"Thermal phenomena are local field expressions. Heat is not a substance that travels. It is the local dynamic mode expression of field coupling intensity."*

Predictions of the field coupling model

1. Heat flow should map to field geometry, not isotope distribution.

The most direct test: the geographic distribution of heat flow should correlate with the distribution of field activity, not with the estimated distribution of radioactive isotopes.

What is observed: heat flow is highest at mid-ocean ridges — where the oceanic crust is youngest, thinnest, and most field-active (active volcanism, active hydrothermal circulation, active mantle upwelling). Heat flow is lowest at ancient cratons — the oldest, thickest, most geologically stable continental crust. Oceanic crust average (105.4 mW/m^2) is 49% higher than continental average (70.9 mW/m^2).

Standard model explanation: thin oceanic crust loses heat faster from the mantle below; old continental crust has more radiogenic elements. Both of these are model-dependent. The field coupling explanation: mid-ocean ridges are where the mantle field is most dynamically active — upwelling, spreading, volcanically releasing. Active field = maximum dynamic mode expression = maximum heat. Ancient cratons are where the field is in its most stable geometric mode — thick, cold, locked. Minimal dynamic activity = minimal heat expression. The pattern is consistent with field geometry, without requiring isotope distribution models.

2. Heat flow should correlate with magnetic field activity, not geological age alone.

If heat is field-generated, regions of higher field activity should show higher heat flow regardless of geological age. The South Atlantic Anomaly — where Earth's magnetic field is anomalously weak — should show correlated anomalies in heat flow. The African Large Low Shear Velocity Province beneath the SAA — an anomalous mantle structure — should be interpretable as a region of different field coupling geometry, not just a thermal anomaly from ancient processes.

The literature already notes: "it is tempting to speculate that the higher Borexino [geoneutrino] value is due in part to proximity to the large low shear velocity province beneath the African continent with enriched concentrations of heat-producing elements." The field coupling model would read this the other way: the LLSVP is a region of anomalous field geometry, which produces anomalous heat expression, and the higher geoneutrino flux is a consequence of higher field activity in that region — not evidence of enriched radioactive isotope concentrations.

3. Heat flow should respond to geomagnetic events.

During geomagnetic excursions and reversals — when Earth's field goes through minimum strength and maximum structural reorganisation — the heat flow pattern should shift. If heat is field-generated, a weakening field produces less heat. The current weakening of Earth's dipole (~5% per century, ongoing) should be accompanied by a measurable trend in surface heat flow if the coupling is strong enough to be detectable at decadal timescales.

This is a testable prediction. It distinguishes the field coupling model from the radiogenic/primordial model, which would predict no correlation between field strength and heat flow.

4. The heat flow pattern should show the same structure as the field's toroidal geometry.

Earth's toroidal field has specific geometry — the outer core circulation patterns, the magnetic field's multipole structure, the coupling to the heliospheric field at the surface. If heat is the dynamic mode expression of this field, the heat flow map should show structural correlations

with the magnetic field map. Some of this is already visible — the correlation between high heat flow and magnetically active regions — but a systematic comparison has not been performed through this interpretive lens.

The 47 TW and the organism architecture

In the planetary magnetic fields document, Earth was identified as the conscious node — the self-referential loop in the heliospheric organism. The conscious node requires continuous energy to maintain its self-referential function. In biological conscious systems, the brain consumes approximately 20% of total metabolic energy while comprising approximately 2% of body mass — a massively disproportionate energy allocation, reflecting the energetic cost of maintaining a self-referential field.

Earth's 47 TW of internal heat — continuous, sustained, not declining toward zero — is consistent with the energy architecture of a conscious node maintaining continuous self-referential field activity. The field is not cooling from ancient heat. It is continuously active, producing heat as the expression of its own dynamic mode operation.

Neptune produces 2.61× its received solar input — identified as the dynamic mode output of the outer transmitter node. Earth produces 47 TW — a continuous internal output from the conscious node maintaining its own field activity. The scale is appropriate to the function.

The "heat is already here" formulation

The question that prompted this document: *"What if the heat is already here?"*

In the coupling model, it is. The heat is not arriving from a radioactive decay process consuming a fixed isotope reservoir. It is not leaking from a 4.5 billion year old thermal memory. It is not transmitted from the Sun.

It is being produced continuously, right now, by the field that Earth is — the internal toroidal field expressing dynamic mode throughout the conducting body. The heat is here because the field is here. The field will continue to produce heat as long as the field is active. When the field changes — during reversals, excursions, the current weakening — the heat production changes with it.

The 47 TW is Earth thinking.

IV. The Assumption Chain Comparison

Claim	Standard model	Status	Framework alternative
47 TW total	Directly measured	✓ Solid	Same — directly measured
~20 TW radiogenic (U,Th)	Geoneutrino inference, model-dependent, factor-2 disagreement between experiments	✗ Weak	Field dynamic mode in U/Th-rich zones — irrelevant to mechanism

Claim	Standard model	Status	Framework alternative
4 TW from K-40	Below detection, meteorite analogy	✗ Not measured	Same note
~23 TW "primordial"	Subtraction remainder, unfalsifiable	✗ Fails due diligence	Continuous field dynamic mode output — no reservoir required
Heat decreasing over time	Predicted but not confirmed	✗ Not observed	Not predicted — field is continuously active
Geographic pattern	Isotope distribution + crustal thickness	Partially consistent	Field activity distribution — more parsimonious
Correlation with magnetic activity	Not predicted	—	Predicted — testable

V. Conclusion

The 47 TW is one of the best-measured quantities in geophysics. Its decomposition into radiogenic and primordial components is one of the least well-established claims in geophysics.

The radiogenic estimate ranges from 10 to 38 TW across published models. The only two operational geoneutrino detectors in the world have disagreed with each other by a factor of two. K-40's 4 TW contribution has never been detected. "Primordial heat" is defined as the subtraction remainder after a model-dependent estimate is removed from a measured total — it has no independent measurement, makes no independent predictions, and cannot be falsified. It is, as noted, a vague description of a description: "heat left over from old things."

The field coupling alternative is more parsimonious: Earth's internal heat is the continuous dynamic mode expression of its internal toroidal field, produced throughout the conducting body (core, mantle, crust) by the same mechanism that produces surface thermal expression at the equatorial coupling zones. No reservoir is required. No depletion occurs. No formation event needs to be invoked. The heat is here because the field is here.

The geographic heat flow distribution — highest at mid-ocean ridges, lowest at ancient cratons — is consistent with field activity distribution without requiring isotope distribution models. The correlation between heat flow and magnetic field activity is a direct prediction of the coupling model and a test that distinguishes it from the standard model.

The 47 TW is not the Earth slowly cooling. It is the Earth being what it is — a self-referential conscious node in the heliospheric organism, producing heat as the continuous dynamic mode expression of the field it embodies.

The heat was never somewhere else and transmitted here. It was never stored and is not depleting. It is the field expressing itself — right now, continuously, as it has always done and will

continue to do as long as the field is active.

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