Proceedings of the
Latin-American Geothermal Congress 2025
LGC 2025
San Salvador, El Salvador
22–26 Sept. 2025

South America Review - Global Heat Flow Database from IHFC

J. Camilo Matiz-León*[1], Jeffrey Poort[2]
[1] Universidad Nacional de Colombia and Heatflow.Felloship IHFC
(E-mail: jmatizl@unal.edu.co)
[2] L'Institut des Sciences de la Terre de Paris - UMR 7193 (ISTeP) and Sorbonne Université
(E-mail: jeffrey.poort@sorbonne-universite.fr)

Keywords: Global Heat Flow Data Base, Heat Flow, data-base structure, HeatFlow.fellowship, South America, Colombia.

Abstract: At the time of this review (Fall 2023), the South American segment of the Global Heat Flow Database (GHFDB), curated by the International Heat Flow Commission (IHFC), contained nearly 6,000 continental and marine heat-flow (HF) determinations—approximately 7.8 % of the global dataset. As part of the HeatFlow Fellowship sponsored by International Heat Flow Commission (IHFC), the Helmholtz Centre for Geosciences (GFZ) and hosted by L'Institut des Sciences de la Terre de Paris - UMR 7193 (ISTeP) and Sorbonne Université, a comprehensive reassessment of the South American entries was undertaken using the updated IHFC evaluation framework (Fuchs et al., 2023). For the first time, continental HF data from Colombia were integrated into the global repository. To support methodological tracking and technical quality control, a custom interactive dashboard was developed. This dashboard enables real-time filtering, geospatial visualization, and metadata diagnostics based on tectonic plate, country, and publication year. Results indicate a continental HFmean of 173.9 mW m^{-2} and marine HFmean of 31.8 mW m^{-2}, with a marked dominance of oceanic records (~80 %). High heat-flow clustering is observed along the Andean arc and marginal basins. Notably, metadata mismatches reached 44 % for plate assignment and 31 % for country fields, emphasizing the urgent need for metadata curation. This approach illustrates the added value of dashboard-driven analytics for identifying data inconsistencies, improving legacy geothermal datasets, and guiding exploration priorities in heterogeneous but data-rich regions.

1. Introduction

The Global Heat Flow Database (GHFDB), curated by the International Heat Flow Commission (IHFC), is the most extensive repository of terrestrial heat-flow data, with over 73,000 continental and marine entries. In response to evolving standards, the IHFC adopted a revised quality framework based on a hierarchical parent–child data structure and FAIR principles [1], enabling traceable evaluation of methodological and environmental parameters.

In this context, the IHFC and the GFZ launched the HeatFlow Fellowship to enhance regional data stewardship. In fall 2023, the first South American fellow, hosted by ISTeP–Sorbonne Université, conducted a systematic review of South American records under the new IHFC scheme. For the first time, continental data

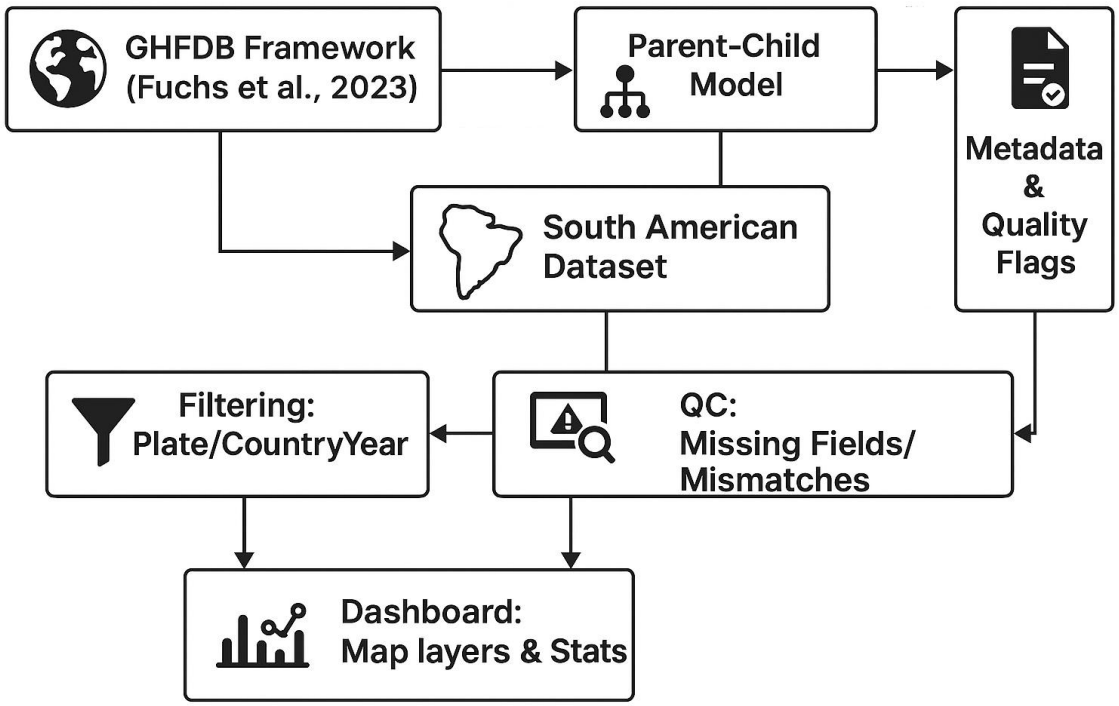
from Colombia—geothermal gradients, thermal conductivity, and surface heat flow—were integrated into the GHFDB, improving regional coverage in the northern Andes.

To support the review of over 5,700 stations, a custom GIS-based dashboard was implemented. This tool enabled real-time filtering, geospatial analysis, and metadata auditing by plate, country, year, and method. The dashboard proved essential for identifying inconsistencies, addressing spatial gaps, and aligning the dataset with IHFC quality standards.

2. Methodology

The data review was conducted under the guidelines of the updated structure of the Global Heat Flow Database (GHFDB), as proposed by [1], [2]. This framework introduces a hierarchical parent–child system, where each site (parent) can host multiple heat-flow determinations (children) with independent metadata entries. This design allows the database to accommodate variability in measurement conditions, instrumentation, and corrections applied for heat transfer mechanisms, thermal properties, transient perturbations, and geological heterogeneity. The methodological process used in this research is present in the Figure 1.

Figure 1. Methodological design for the South American Review + Dashboard



The evaluation of each entry followed the quality assessment scheme developed by the IHFC, which integrates three scoring components: (i) numerical uncertainty (U-score), (ii) methodological robustness (M-score), and (iii) the presence and

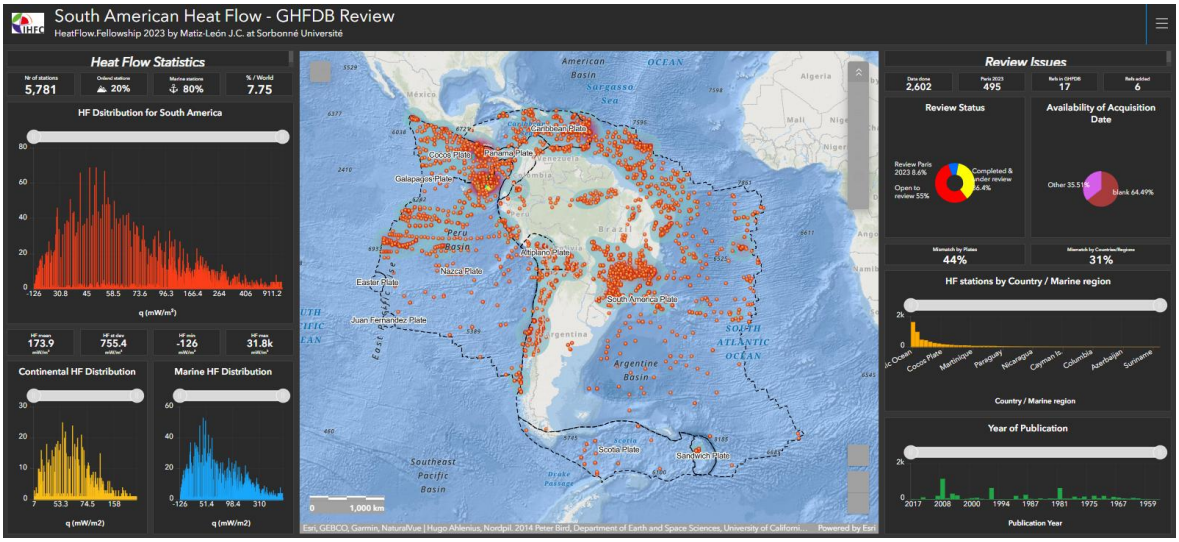
correction status of site-specific perturbations (p-flags). These indicators enable a systematic classification of heat-flow data quality and are fully traceable within the database structure. The updated GHFDB framework also adheres to FAIR data principles, ensuring findability, accessibility, interoperability, and reusability of the entries through the inclusion of persistent identifiers (DOI, IGSN) and standardized metadata.

To streamline the review process and facilitate quality control, a custom GIS-based dashboard was developed. This tool allowed real-time visualization and filtering of over 5,700 entries based on key parameters such as tectonic plate, country, acquisition year, and measurement method. The dashboard integrates interactive histograms, pie charts, and geospatial layers that highlight inconsistencies in metadata assignment—such as misclassified plates or countries—and reveal geographic gaps in the dataset. By aligning with the IHFC quality field scheme, the dashboard enabled a rapid and reproducible visual audit, significantly enhancing the traceability and transparency of the review.

3. Results

As part of the Global Heat Flow Database (GHFDB) Release 2024, a total of 91,182 heat-flow determinations were compiled globally, including 57% continental and 43% marine records from 1,586 publications spanning 1939 to 2024 [3]. The South American segment contributed nearly 6,000 entries, of which 5,701 were systematically reviewed in this study using the IHFC quality-assurance framework. A major outcome was the incorporation of 99 continental records from Colombia—absent until now—mainly from the Llanos Orientales Basin [4], [5]. These include geothermal gradients, thermal conductivities, and heat-flow estimates from theses, governmental reports, and exploration surveys. Their addition improves thermal resolution in the northern Andes and foreland basins. All records follow FAIR data standards and carry persistent identifiers (DOI, IGSN). To support the review, a custom GIS-based dashboard was developed to interactively explore the 5,701 entries. The dashboard enabled filtering by country, tectonic plate, acquisition year, and environment type, and allowed real-time detection of metadata inconsistencies and spatial gaps (Figure 2). For access to the dashboard: https://fl-su.maps.arcgis.com/apps/dashboards/1c13be3cc42f43a5b3f8771d424e0058.

Figure 2. Methodological design for the South American Review + Dashboard



Analysis revealed a strong marine bias: 80% of records are oceanic, mainly along the Nazca Plate, and 20% continental. Chile contributed the most entries (>1,500), followed by Argentina and Brazil. With its new records, Colombia now contributes 99 continental entries. The tectonic plate panel showed that nearly half the dataset was assigned to the Nazca Plate. However, several inland sites in Colombia, Ecuador, and Peru were misclassified under oceanic domains, yielding 44% mismatch by plate and 31% by country. Temporal filtering revealed two acquisition peaks: one in the 1970s–1980s, and a second in the 2010s–2020s, linked to geothermal exploration. The integration of charts, maps, and filters enabled a robust audit aligned with IHFC protocols and supported data quality improvements across South America.

4. Discussion

The integration of South American records into the updated GHFDB reveals both opportunities and challenges in managing legacy geothermal datasets. The addition of Colombian data fills a significant spatial gap in the Andean–Amazonian region and underscores the value of national efforts in geothermal characterization. However, the high rates of metadata mismatch—particularly by plate and country assignment—highlight persistent inconsistencies inherited from historical compilations. The dashboard-driven audit demonstrated that visual and interactive tools are effective not only for quality control, but also for identifying patterns in data density, acquisition periods, and tectonic context. These tools can accelerate regional harmonization and inform future data acquisition strategies, especially in underrepresented zones such as northern South America.

5. Conclusions

This study contributed to the 2024 update of the Global Heat Flow Database by reviewing over 5,700 South American entries and integrating, for the first time, 99

continental heat-flow records from Colombia. The work was guided by the IHFC's new evaluation framework and supported by a custom dashboard that enabled real-time filtering and visual diagnostics. The results highlight both the uneven distribution of heat-flow data across the continent and the potential of interactive platforms to improve metadata integrity. Colombia's formal inclusion in the GHFDB marks a critical step for regional geothermal studies and sets a precedent for future FAIR-compliant data contributions in Latin America.

Acknowledgment: The authors would like to express appreciation for the support of the International Heat Flow Commission (IHFC), the Heatflow,fellowship programme, the Helmholtz Centre for Geosciences (GFZ), L'Institut des Sciences de la Terre de Paris - UMR 7193 (ISTeP), and Sorbonne Université (SU) for the sponsorship, technical guidance, and the hosting for culminate the fellowship.

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