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Open at the interface, closed at the core: neutrality claims in AI-enabled geoscience infrastructure focusing on Africa – The case of Deep-Time Digital Earth and GeoGPT

Paul H. Cleverley[*,1], *Ezzoura Errami*[2], *Tania R. Marshall*[3], *Simon Burnett*[1], *Andrew O. Lator*[4], *Ibeke Ebuka*[1]

[1] Robert Gordon University, Scotland, United Kingdom

[2] Chouaïb Doukkali University, Morocco

[3] University of Witwatersrand, South Africa

[4] Geomatics Nigeria, Limited, Nigeria

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Abstract

Geological data has become strategic infrastructure for resource assessment, investment negotiation, and economic sovereignty. Remotely hosted big data and Artificial Intelligence (AI) platforms are increasingly promoted for geoscience in the Global South, particularly Africa. Whether such platforms are genuinely geopolitically unaligned, and how this can be verified, has direct implications for scientific autonomy and data sovereignty.

Using Deep-time Digital Earth (DDE) and GeoGPT as a critical case, this paper examines whether claims of geopolitical non-alignment can be independently verified. DDE was suspended by its founding body, the International Union of Geological Sciences (IUGS), in early 2025, yet its non-alignment claims have continued. Drawing on UNESCO Open Science and AI Ethics frameworks, the paper assesses three criteria: governance independence, data and software openness, and AI transparency.

The analysis reveals a distinction between user-interface accessibility and core technical verifiability. Core DDE/GeoGPT software remains proprietary, and the platform and models diverge from definitions of 'openness' and 'digital public goods' established by UN-backed frameworks, and the AI Ethics Recommendations from UNESCO. The documentary record also shows governance and funding concentrated in a single national jurisdiction, including links between DDE collaboration targets and China's Belt and Road Initiative, a 2026 agreement with the mining investment department of the China-Africa Development Fund, and advisory structures that include individuals with documented affiliations to the national resource-extraction sector. Combined, their significance lies in the gap they create between the platform's claims and what can be independently verified.

AI governance documentation discloses filtering of content deemed politically sensitive; in one documented instance, a response citing peer-reviewed research on state censorship was replaced by a refusal. The criteria and scope of this filtering are not fully disclosed, leaving it un-auditable.

The paper concludes that it is currently not possible to verify claims of non-alignment using this framework; DDE/GeoGPT is best characterised as what we term a state-anchored international platform: globally participatory, but dependent on a single national jurisdiction. The criteria provide a transferable test for comparable claims and highlight the importance of calibrated engagement with external platforms, and use of open-source and sovereign alternatives where privacy or geological data sovereignty is at stake.

Keywords: Geoscience, Geology, Geodata, Geospatial, Africa, Energy transition, Critical minerals, Oil and gas, Artificial Intelligence, Data sovereignty, AI ethics, Geoethics, Geopolitics, Cyberinfrastructure, Science diplomacy.

1. Introduction

To support the UN Sustainable Development Goals (SDGs) including the energy transition, geological data has become key infrastructure for assessing resources, negotiating investment, and preserving economic sovereignty (Stocks et al., 2019; IEA, 2021; Hund et al., 2023), with big data and AI increasingly central to critical-mineral and oil and gas exploration (Hadid et al., 2024; Davies et al., 2025; Sinding-Larsen et al., 2025).

International relations are increasingly defined by "geotechnology disputes" alongside traditional geopolitics, as states deploy science diplomacy to secure control over data, infrastructure, and digital tools (SITC, 2026). For many African countries, geoscientific data infrastructures are also tied to resource governance and data sovereignty with a need to develop their own technologies (AMDC, 2016; Busia and Akong, 2017; Nguno et al., 2025). This sits in a context of intensifying geopolitical competition between the US and China, in which AI is framed as an instrument of statecraft (Turekian and Gluckman, 2024; UNESCO, 2025a). Some Global South governments and scholars have increasingly framed sovereignty concerns in relation to critical-mineral strategies and cloud infrastructure associated with both Western and Chinese actors (Boafo et al., 2024; Moyo, 2025; Freitas, 2026).

The extent to which AI-enabled international geoscientific platforms can be 'geopolitically unaligned' therefore has direct consequences for African scientific engagement, autonomy, and capacity. Existing literature has not established what non-alignment requires in practice, or how such claims can be verified. This paper addresses that gap using Deep-time Digital Earth (DDE) and GeoGPT – selected as the only known AI-enabled geoscience cyberinfrastructures that explicitly claim geopolitical non-alignment – to examine whether such claims are independently substantiated. The case is particularly apt given its sustained emphasis on neutrality and stated focus on the Global South, especially Africa (Wang et al., 2021; DDE, 2025b).

Drawing on UNESCO's Open Science and AI Ethics Recommendations, the paper examines governance independence, openness, and AI transparency as the conditions under which verification can occur, leading to the following research questions:

> *RQ1: To what extent do the institutional conditions governing DDE and GeoGPT support transparent, contestable, and independently verifiable claims of geopolitical non-alignment?*
> *RQ2: What are the structural implications of participation in AI-enabled international geoscience platforms, with particular reference to African geoscience institutions?*
> *RQ3: How does the structural asymmetry between externally governed platforms and sovereign alternatives shape the conditions under which African and other Global South institutions can engage on equitable, auditable terms?*

The following section reviews the relevant literature, followed by the Methodology, Results, Discussion and Conclusion including areas for further research.

2. Literature review

2.1. Geopolitical non-alignment

An ideal geopolitically unaligned science initiative is independent of state or bloc direction, open and equitable in participation, and governed by scientific rather than political authority (Merton, 1942; Polanyi, 2000; Ruffini, 2017). Openness alone is not sufficient for non-alignment (Tallberg et al., 2013; Vikberg, 2024); science directed toward national strategic priorities is instead considered aligned (Jasanoff, 2004; Ruffini, 2017). US-China decoupling has coincided with rising scientific nationalism, as states tie research to technological self-reliance and state power rather than discovery (Norouzi et al., 2024).

Taking a realist approach, Gluckman et al. (2017) reframe the Royal Society/AAAS (2010) taxonomy as a spectrum from nationally aligned to globally oriented action, each configuration reflecting a different institutional settlement (Wagner, 2018). What makes alignment assessable, then, is the independence of the governance through which it operates – governance not appointed by, funded by, or accountable to the entity it oversees (Gilardi and Maggetti, 2011; OECD, 2016; Laux, 2024). Such autonomy is relational rather than absolute, depending on avoiding dominance by any single resource provider (Ennser-Jedenastik, 2016; Gläser et al., 2022).

Knight (2022) frames 'knowledge diplomacy' as a counter to 'soft power': state-linked initiatives with genuine self-interest can still do legitimate, reciprocal work, without geopolitical non-alignment as a condition of legitimacy. Ruffini (2020) argues mainstream narratives magnify cooperation while under-representing science diplomacy's competitive use in foreign policy – a pattern traced first to Western practice. Huang and Meng (2025) similarly characterise Chinese tech diplomacy as 'intermestic', binding domestic science policy to foreign policy via frameworks like the Belt and Road Initiative and asserting 'discourse power' to legitimise China-led norms.

Across science, digital, and tech diplomacy, the relevant question is not whether alignment exists but whether the institutional conditions governing it are transparent, contestable, and independently verifiable. This has particular force for geology, where what gets studied, how it's framed, who funds it, and how it is applied are socially and politically situated rather than neutral (Westermann, 2015; Bobbette and Donovan, 2019; Peppoloni and Di Capua, 2021). Some scholars see a need for closer engagement between geoscience and the social sciences – addressing colonial legacy in extractive industries, community mobilisation, social justice, geoethics, equity and inclusion (Stewart et al., 2023).

2.2. Assessing geopolitical non-alignment in online platforms

The cloud infrastructure on which data-intensive research runs shapes where data accumulates and whose law governs its processing, entangling provision with digital sovereignty (Goldsmith, 2007; Floridi, 2020; Freitas, 2026). Whether under the US commercial default, the publicly governed European cloud (EC, 2024), or the Chinese stack, hosting can expose even locally stored data to extraterritorial law (Woods, 2017), making cyberinfrastructure a matter of institutional and geopolitical alignment rather than neutral technical provision (Turekian and Gluckman, 2024; de Reuver et al., 2026).

Assessing geopolitical non-alignment in online cyberinfrastructures is therefore multidimensional (Winner, 1980; Wagner, 2018; Ruffini, 2020): control must be assessed empirically, since formal autonomy can coexist with disproportionate influence, and participation does not itself constitute equitable influence (Marquardt, 2017; OECD, 2018; ISC, 2024).

Open science seeks to make scientific knowledge, methods and data accessible, transparent and reusable (UNESCO, 2021a). Findable, Accessible, Interoperable and Reusable (FAIR) principles operationalise this for data but do not address whether infrastructure, software, models or AI training data can be independently inspected, modified or redeployed (Wilkinson et al., 2016); that gap is addressed by AI ethics frameworks emphasising transparency, explainability and accountability (UNESCO, 2021b; ISC, 2024). CARE principles (Carroll et al., 2020) add authority, benefit, and responsibility considerations that FAIR does not resolve.

A parallel gap exists within the UNESCO Open Science Recommendation itself (UNESCO, 2021a). Open science infrastructures are defined functionally, by the research activity they support, rather than by the openness of their own components; not-for-profit organisation, community governance, and open-source solutions are encouraged for such infrastructures but are not definitional requirements. A proprietary, free-to-access platform hosting open data can therefore satisfy the definition of open science infrastructure while diverging from the norms the Recommendation attaches to it, and, where AI-enabled, simultaneously diverge from the transparency provisions of the UNESCO AI Ethics Recommendation (UNESCO, 2021b).

Big science initiatives (CERN, CyVerse, the Human Genome Project) and fully open-source research Large Language Models (LLM) such as OLMo show end-to-end openness is technically achievable from the outset, making its absence an institutional choice rather than a technical inevitability (Ramachandran et al., 2021; Groeneveld et al., 2024; Swetnam et al., 2024; OLMo, 2026).

Digital Public Goods (DPG) are defined (in the UN Secretary-General's Roadmap for Digital Cooperation and operationalised by the Digital Public Goods Alliance's DPG Standard) as having an open-source compliant software license (OSI, 2026), publicly released training data and code, and open AI models that adhere to privacy and other applicable laws, do no harm and advance the SDGs (UNSG, 2020; DPGA, 2024; DPGA, 2025). The United Nations University reaches a consistent conclusion for AI as DPGs, recommending the Model Openness Framework (White et al., 2024) to describe degrees of openness (UNU, 2026).

Widder et al. (2024) identify three affordances of open AI – transparency, reusability and extensibility – noting that openness claims frequently attach only to one visible layer, most commonly model weights, while the surrounding application, data, governance and infrastructure remain closed. Eaves et al. (2022) make the mechanism plain: whoever controls a project's strategy board controls its roadmap, and the largest resource contributor typically accrues the most influence.

Political and institutional assumptions may become embedded through LLM training data, narrative shaping and filtering mechanisms (Buyl et al., 2026; Colville, 2026; IISP, 2026; Lim and Röttger, 2026; Pan and Xu, 2026; Qiu et al., 2026) which has the affordance to spill over, impacting apolitical content (Hawkins, 2024; Pan and Xu, 2026). As geological-model reliability depends on the representativeness of the underlying data (Wellmann and Caumon, 2018), technical bias may exist in the training data where models built around one regime may transfer poorly to other structurally distinct terrains.

Bias here is the systematic embedding of institutional and political assumptions in systems that present themselves as neutral (Winner, 1980; Bowker and Star, 2000; Gillespie, 2010; Birch, 2025). Because algorithms mediate between users and data, assessing bias requires reproducing outputs and interrogating the data, code, models, and parameters that mediate them (Mitchell et al., 2019; Bender et al., 2021; UNESCO, 2021b; ISC, 2024).

2.3. Geoscience cyberinfrastructures

At the international level, OneGeology (2008-2026) is an example of free geoscience cyberinfrastructure (OneGeology, 2026a). It was funded by member organisations (OneGeology, 2020) hosted by the British and French Geological Surveys with multilateral governance and open-source federated infrastructure preserving exit, so no single nation gained advantage (Cowan, 2008; OneGeology, 2010; Komac et al., 2016). The China Geological Survey, for example, still runs its own sovereign instance of OneGeology (CGS, 2016).

In contrast, the nationally funded and directed US programme, EarthCube, restricted funding to US institutions (White House, 2012; EarthCube, 2019, 2026). It shows that nationally governed infrastructure can make free-to-use proprietary tools (xDD, 2026) and meaningful open-source contributions (EarthCube, 2021, 2022a, 2022b) without claiming geopolitical non-alignment.

Freely available, general-purpose LLMs, such as US and Chinese-origin, spanning open-weight models and free-to-use proprietary hosted services are widely used to support geoscience workflows (Baucon and de Carvalho, 2024; Pantiukhin et al., 2025; Widlansky and Komar, 2025). Domain-specific LLMs can be outperformed by general-purpose models under domain prompting (Kojima et al., 2022; Nori et al., 2023; Baucon and de Carvalho, 2024), though some release training data and weights for reproducibility (Atrio et al., 2026; EVE, 2026a, 2026b). Multimodal earth-observation models using geospatial embeddings of satellite imagery have also emerged, some fully reproducible and deployable, such as OLMoEarth (Tseng et al., 2026).

The intergovernmental Group on Earth Observations (GEO) infrastructure hosted by European countries and China, operationalises "*neutrality*" for a planned AI-enabled geoscience platform using open-source software and open models (GEO, 2025, 2026), so the community can "*inspect, customise, and continuously improve the underlying models and pipelines, reducing vendor lock-in*" (GEO, 2026). The document states if any LLM-based workflows are implemented as a user interface, "*the deployment must be fully in-house, hosted entirely within the GEO Infrastructure environment… eliminating dependency on external services that could compromise data sovereignty or introduce license issues or privacy concerns*".

The only current identifiable AI-enabled international geoscience infrastructure in operation that explicitly makes claims of geopolitical non-alignment is the technology platform of the DDE programme including GeoGPT (Wang et al., 2021; GeoGPT, 2026a).

2.4. Focus on Africa

Geoscience data in Africa has historically been held by colonial surveys and universities. A three-part system is now emerging, geological surveys, academic institutions, and mining bodies, but most remain weakly funded and poorly connected across borders (Nguno et al., 2025). The Geological and Mineral Information System (GMIS) improves open access to some countries' geological data but remains unevenly distributed across the continent (GMIS, 2026).

The Africa Mining Vision explicitly frames mineral development as a pathway from raw material export dependency toward knowledge-based sovereign capacity (Busia and

Akong, 2017). Critically, it identifies investment in geological knowledge infrastructure as key, noting that the less a state knows about its resources, the greater the share of rents an investor will demand (AU, 2009), framing geological survey capability not as a technical preference but as a sovereign negotiating prerequisite.

Data sovereignty, the idea that people, communities, organisations, or nations should have meaningful control over data related to them (Hummel et al., 2021), compounds these gaps. The Pan-African Parliament (2025) notes that African data is frequently stored and processed outside the continent risking data misuse, while the African Union Data Policy Framework and African Digital Transformation Strategy (2020-2030) emphasise trusted African governance and equitable development as prerequisites for beneficial participation (AU, 2020, 2022). African geological societies along with numerous international bodies have endorsed AI ethics recommendations in the geosciences that promote transparency and safeguard data sovereignty (Cleverley et al., 2025).

Open-source tools like QGIS with AI/ML plug-ins increasingly support capacity building and data sovereignty in the geosciences (Benade and Ajayi, 2025), while free satellite and remote sensing data help African geoscientists with tasks from mineral exploration to groundwater and landslide monitoring (Misbah et al., 2024; Nnaji et al., 2024; Shebl et al., 2024). Nwaila et al. (2024) demonstrate a sovereign AI pathway for mineral prospectivity mapping, built on open-source tools and nationally held survey data, though the institutional capacity that enabled it is not uniformly present across the continent (AMDC, 2016, 2018, 2025; Nguno et al., 2025). Emerging compute infrastructure being deployed in numerous African countries over the next few years may enable a broader shift from being consumers of AI to producers of AI (Gilbert, 2026).

Where these conditions are absent, participation in externally governed AI platforms proceeds on terms set by powerful external actors – the structural asymmetry Ruffini (2020) and Wagner (2018) anticipate, and one African scholars have already identified (Boafo et al., 2024; Pan-African Parliament, 2025; Effoduh, 2026). The risk extends beyond data sovereignty to epistemic sovereignty (Effoduh, 2026): who controls the analytical frameworks, training data, and AI outputs through which African geological knowledge is produced. Opacity in any of these dimensions limits the independent verification on which neutrality-like claims depend.

This structural reading is affirmed by the UN's Independent International Scientific Panel on AI, which concludes that the AI divide "*goes beyond the connectivity gap*" and that countries relying on foreign models, cloud infrastructure and data pipelines "*may gain access to AI while losing practical control over its standards, safeguards and local fit*" (IISP, 2026). Capacity, on the Panel's assessment, is defined by the ability to influence AI development, not by access alone.

3. Methodology

3.1. Research design

Case study methodology is appropriate for questions of institutional design and governance in context (Yin, 2018); strategically selected single cases can support analytical generalisation where selection is justified (Flyvbjerg, 2004). Selection rests on DDE/GeoGPT being the only identifiable platform of this type making sustained, explicit non-alignment claims (Section 2.3), examined across three analytically distinct units: governance, data and software openness, and AI transparency (Yin, 2018).

DDE and GeoGPT are treated as a single case. GeoGPT originated within the International Union of Geological Sciences (IUGS)-DDE programme (Zhen, 2023; DDE, 2024a). GeoGPT governance was changed to Zhejiang Lab (co-founded by Alibaba) in March 2025, shortly before the IUGS suspension of DDE (GeoGPT, 2026d). A Memorandum of Understanding created at the time commits DDE and Zhejiang Lab to jointly "develop" and "promote" GeoGPT and provides for GeoGPT representatives to attend DDE's governance meetings (DDE, 2025j). It is also reported that the DDE Zhejiang Center (which builds much of the DDE platform) has been integrated with Zhejiang Lab (DDE, 2026d). DDE staff lead GeoGPT's strategic direction, design and promotion (whilst claiming non-alignment), and along with Alibaba Cloud Executives, are part of the Executive Team of GeoGPT (IUGS, 2024b; DDE, 2026c). GeoGPT depends on DDE technology and advances neutrality claims itself (IUGS, 2024a, 2024b; GeoGPT, 2026d).

3.2. Analytical framework

Following the socio-technical literature (Section 2.2), systems cannot be assessed for alignment from surface features alone; opacity is therefore analytically significant. The assessment applies the UNESCO Recommendations on Open Science (UNESCO, 2021a) and AI Ethics (UNESCO, 2021b), FAIR Principles (Wilkinson et al., 2016) and International Science Council (ISC) framework for frontier AI (ISC, 2024) as a theoretical framework. These are adopted by international multilateral consensus not national priorities and used as the operational basis of responsible and safe AI by the UN (UN General Assembly, 2024a, 2024b) and are also consistent with the African Union Data Policy Framework (AU, 2022).

Because FAIR and Open Science principles can be satisfied at the interface level while computational processes remain unverifiable (Section 2.2), the UNESCO and ISC AI principles are combined with them to capture both power asymmetry and epistemic openness. The case study analysis is structured around tendencies for three operational criteria derived from these frameworks.

- Governance independence: whether technology decision-making authority is genuinely autonomous, free from financial conflicts of interest, and multilaterally constituted rather than concentrated in a dominant national actor.
- Data and software openness: whether platform data, code, and infrastructure are freely accessible, reusable, and deployable independently of the platform, avoiding dependencies.
- AI transparency and explainability: whether models, training data, and parameters are sufficiently disclosed to allow outputs to be reproduced and interrogated for bias.

Verifiability does not require a single pathway: technical opacity can be compensated procedurally where genuinely independent, externally audited multilateral governance exists, though this does not substitute for openness on every dimension (Section 5.3). No single finding is sufficient: the conclusion rests on the cumulative pattern of unresolved cases.

3.3. Data collection and analysis

English and Chinese searches identified governance documents, platform agreements, terms of use, and academic and grey literature relating to DDE and GeoGPT. These documents include interviews with DDE representatives (IUGS, 2024b) and internal DDE self-reflection reviews (DDE, 2024b). Institutional rhetoric was analysed alongside omissions, ambiguities and contradictions rather than treated as evidence of practice (Bowen, 2009).

Bibliometric analysis (Wagner, 2018) examines authorship, institutional affiliation, and publication patterns as a corroborating signal of whether participation and knowledge production reflect the equity implied by non-alignment claims. The analysis used the Dimensions database, chosen for its broader coverage of Global South publications than other major indexes (Asubiaro and Onaolapo, 2023), identifying publications via the phrase “deep-time digital earth” in funding or acknowledgement fields to minimise incidental inclusion – though this likely misses’ articles that used DDE resources without acknowledging them this way. The dataset was analysed by lead-author affiliation to assess concentration of output, with journal-title counting as a transparent, reproducible proxy for theme (Leydesdorff and Rafols, 2009).

This study adopts a structural and architectural critique rather than empirical output testing: model outputs vary across runs and updates, whereas the infrastructural, data-governance, and deployment systems examined here shape behaviour at scale.

4. Results – Case overview of DDE and GeoGPT

4.1. Overview of the case

DDE was initiated in 2018 by IUGS as a China-led (MOST, 2021; DDE, 2023a) programme aiming to build a global AI-enabled cloud platform linking geological data across Earth's evolutionary history for data-driven discovery (IUGS, 2019; Normile, 2019; Cheng et al., 2020; Oberhänsli, 2020; Wang et al., 2021). DDE's technology platform was launched in November 2022 (DDE, 2022a), with the GeoGPT application made publicly available in early February 2024 and formally released in March 2025 (DDE, 2024a).

DDE is described as an open and collaborative research program supporting open science (UNESCO, 2025b), free to join, with founding members drawn from geological surveys, professional associations, commissions, and scientific organisations. It stated it would not "*strike any agreement with funding agencies that carry the risk of political influence*" (Wang et al., 2021). It declared its "*non-aligned geopolitically*" status an existing strength in its 2025-2028 strategic framework (DDE, 2025a; p. 3) endorsed after the IUGS suspension.

Wang et al. (2021) list 18 founding members, invited by IUGS (IAG, 2019). Its technological vision was to integrate public databases into Knowledge Graphs and an online 'Geological Google' crawling structured and unstructured geoscience literature, including journals, books, governmental reports and corporate records (Cheng et al., 2020; DDE, 2021; Wang et al., 2021). The emergence of OpenAI's ChatGPT in 2022, expanded the DDE vision to include a 'Geological ChatGPT' (GeoGPT, 2026a). DDE has made substantial open-science contributions, including research tools, linked databases, international projects (e.g., a research centre of excellence in the Democratic Republic of Congo (DRC), a critical minerals study in Nigeria and mineral evolution in the US), publications, funding contributions to a World Digital Geological Map, and metadata standards (DDE, 2023b).

In early 2024, concerns were reported about "*potential data misuse*" (IUGS, 2025). Several founding members appeared to subsequently withdraw from DDE with their logos removed from DDE's website (DDEWorld, 2024). In late 2024 an IUGS internal review identified numerous transparency and governance shortcomings, recommending an independent financial committee, legal entity for DDE and a digital committee to oversee technology, while noting the platform's self-described strength as "*non-aligned geopolitically*" (IUGS, 2024b) without verifying the declaration. Following reported threats by some members to withdraw from IUGS unless action was taken, the IUGS Executive Committee formally suspended DDE in March 2025 (IUGS, 2025). The following sections examine the claims of geopolitical non-alignment.

4.2. Document analysis

4.2.1. Governance independence

i) Funding and ownership: the international DDE programme was funded by China's Ministry of Natural Resources (for the DDE Secretariat), provincial government sources, including a ~$75 million investment in the Suzhou DDE centre in Kunshan which focuses on China's major national energy resource needs, and host nation NSF research grants (FAO, 2019; Normile, 2019; DDE, 2020a; IUGS, 2024b).

   Some of DDE's formal international investment targets explicitly include the Belt and Road Initiative (BRI), a Chinese state-directed geopolitical investment programme (Nedopil, 2025), as a core criterion for collaboration and recruitment. For example, "*[DDE] Host at least 3 visiting scholars…to design and launch cooperative initiatives…in countries and/or regions participating in China's [Belt and Road] BRI initiative*" and "*Attracting scholars and post-doctoral candidates from countries participating in BRI will also be explored.*" (DDE, 2024b).

   In 2025 China's Ministry of Science and Technology assumed primary funding responsibility for DDE, raising it to ~$14 million with a focus on Africa, relaunching the programme at the second Belt and Road conference on science and technology exchange (DDE, 2025g). Funds were split between the DDE Zhejiang and Suzhou Centres, including allocations for the International Science Initiative (DDE-ISI) (DDE, 2025e, 2026b). The 2025-2028 DDE strategic plan states Chinese government funding of DDE is "*over 90%*", although no evidence of current funding from other sources appears in the documentation or literature as of 2026.

   Ownership of data and technology on the platform is unclear as evidenced by DDE's own records stating that Zhejiang Lab "*owns and operates GeoGPT*" while Zhejiang University "*manages the DDE Platform*" but "*the ownership of the DDE Platform needs further clarification*" (DDE, 2025e, 2026d). From the IUGS review's recommendation in December 2024, DDE reports it expects to finalise a new legal entity for DDE, incorporated in China, mid 2026 (DDE, 2026d).

ii) Institutional design: according to the DDE statutes, the Governing Council is the supreme decision-making body which oversees all DDE activities (DDE, 2020b). Around eight to ten members regularly attend meetings held once or twice a year, including: the China Geological Survey, Geological Survey of Iran, Geological Society of Africa, and several international associations. Some representatives of international commissions/associations who attend DDE on their behalf, also hold responsibilities with Chinese governmental institutions (DDE, 2025d, 2025e).

The DDE Executive Committee is guided by the Governing Council and conducts day-to-day decisions with administration assisted by the Secretariat (DDE, 2020b). The relationships between these entities are mapped in Figure 1 based on available documentation (DDE, 2020b, 2024c; CUGB, 2022a, 2022b; IUGS, 2024b; DDEMR, 2026b; GeoGPT, 2026d; NJU, 2024, 2026).

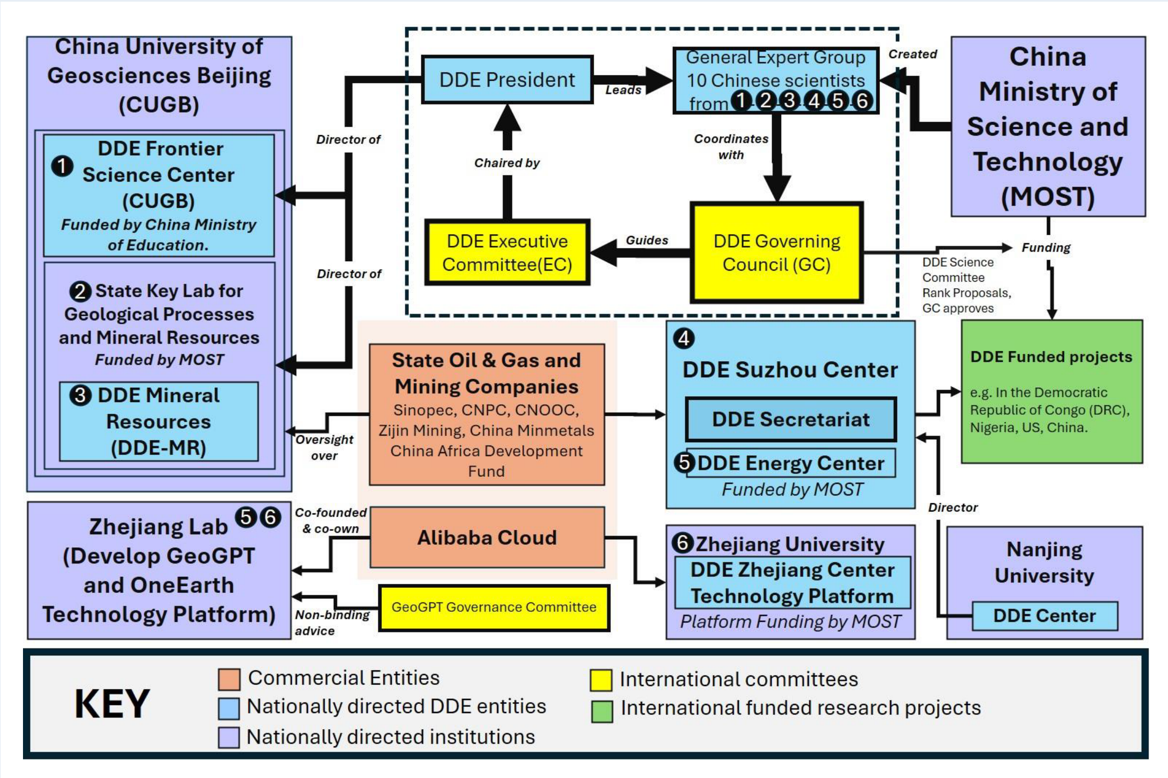

Figure 1. *DDE/GeoGPT entities – those parts reported as independent decision making or advice are shown in yellow.*

Several of those who attend DDE Governing Council meetings are beneficiaries of research funding or compensation from the DDE/GeoGPT actor network, as are some members of the DDE Science Committee, GeoGPT Governance Committee and the DDE Secretariat (DDE, 2025h, 2025i; GeoGPT, 2026d, 2026e). The implications are discussed in Section 5.2.

In December 2024, Zhejiang Lab declared GeoGPT was "*Governed by an independent governance committee*" providing "*governance and strategic* *oversight*" (DDE, 2025l; Zhejiang Lab, 2025). In February 2026, revised terms of reference dropped the "*oversight*" accountability and redefined the committee as an independent non-binding advisory body without operational or managerial oversight, differing from earlier public descriptions (GeoGPT, 2026b, 2026d). However, the Committee continues to communicate at high visibility events that it provides oversight over GeoGPT on ethical standards (ITU, 2026b).

iii) Strategic decision making: since mid-2025, there has been increased transparency of DDE Governing Council and Executive Committee meetings. In December 2025, the Governing Council minutes state DDE will seek to downgrade its status from a project of IUGS, to an affiliate of IUGS, "*to minimize legal and other risks to IUGS members*" (DDE, 2025e).

OneGeology meeting minutes record deliberation and differing viewpoints (OneGeology, 2026b). However, publicly available DDE records document the outcomes of several major strategic decisions without the underlying deliberation, alternatives, or justification, and the available documentation does not clarify any discourse over major strategic technology decisions and risks (DDE, 2025d, 2025e, 2025i).

In 2025 China's Ministry of Science and Technology established a General Expert Group for DDE consisting of 10 Chinese scientists from academia, government and industry to coordinate with the DDE Governing Council (Figure 1) to develop the 2025-2028 strategic framework (DDE, 2025a, 2025d). Documentation records the Group as "*co-adopting*" DDE strategy alongside the Governing Council (DDE, 2025k).

iv) Coexisting framings in the documentary record: this section documents how the programme is framed across different audiences and institutional settings in the public record. Dual national-international framing is a common feature of science diplomacy and becomes significant only in relation to the non-alignment claim.

DDE describes itself to African partners as "*non-aligned*" with "*no geopolitical influence*" (GSAf, 2023) and asserts geopolitical non-alignment as an existing strength of the programme (DDE, 2025a). The same strategic framework's SWOT analysis places "*not for profit and non-aligned geopolitically*" and "*increased funding in China in 2024*" among the programme's strengths, while recording "*funding is not diverse*" and "*perceived China dominance*" as weaknesses (DDE, 2025a). Listed opportunities include work with business and industry on critical minerals and to "*market DDE Platform as an enabler for geodata in the Global South*" (DDE, 2025a).

In DDE/GeoGPT articles, Western aid is portrayed as paternalistic and dependency-producing, while DDE and GeoGPT are presented as mechanisms for shifting power, expertise, and decision-making toward African institutions and researchers (DDE, 2025b, 2025c). The documentation does not explicitly address potential risks to data sovereignty and 'lock-in' dependencies created by using single-jurisdiction-bound hosted platforms that require data upload (GeoGPT, 2026a). Alongside these outward-facing framings, Nanjing University's account of its Africa delegation and DDE mandate records the purpose as to "*serve the national resource and energy security strategy and 'Belt and Road' construction,*" with DDE as the cooperation platform, and notes discussion of "*critical-mineral strategy in the context of the China-US contest*" (NJU, 2026; see Figure 1).

The record also documents interfaces between the programme and state-linked commercial actors. DDE participated in the Investing in African Mining Indaba in Cape Town (February 2026) organising a session that "*fosters Sino-African partnerships for sustainable mineral development*" (Indaba, 2026), where in a session chaired by the DDE Secretariat, it signed a cooperation agreement with the mining investment department of the China-Africa Development Fund (CADFund) (DDE, 2026c; NJU, 2026). CADFund is a political instrument established to "*encourage and support Chinese enterprises to invest in Africa*" (UNIDO, 2015; CADF, 2015). Through a Joint Venture collaborating with the DDE Energy Center, National Oil Companies received exclusive pre-release access to GeoGPT (NEPU, 2024). DDE highlights that GeoGPT could be used to better understand "*critical minerals in West Africa*" and advocates for government departments to use GeoGPT to "*scrutinise the proposals of investors (…from international mining companies)*" (DDE, 2025b).

Personnel overlaps appear across these settings. DDE materials identify the GeoGPT Chief Advisor and a member of the DDE General Expert Group as having publicly documented senior affiliations to China's national resource-extraction sector (DDE, 2025g, 2025m; GeoGPT, 2026d, p. 6). The CADFund agreement was executed for DDE by the Nanjing University delegation's leader, who directs the DDE Suzhou Centre and also sits on the General Expert Group defining strategy (DDE, 2026c; NJU, 2025; 2026). These roles are examined in Section 5.5.

Finally, nationally governed entities are incorporated into outward-facing descriptions of the international DDE programme. DDE facilities at China University of Geosciences Beijing (CUGB), including the DDE Frontier Science Center serving China's National Strategic Priorities, and DDE-MR mineral-resources programme, are presented alongside the internationally framed DDE programme under the same 'DDE' brand (CUGB, 2022a, 2025a, 2025b; DDE, 2025k; CCOP, 2026; DDEMR, 2026a, 2026b; NJU, 2026).

4.2.2. Data and software openness

As shown in Figure 2, technology branded by DDE on its Alibaba cloud platform is developed by entities exclusively from Chinese institutions (Ning, 2021; DDE, 2026a; GeoGPT, 2026a).

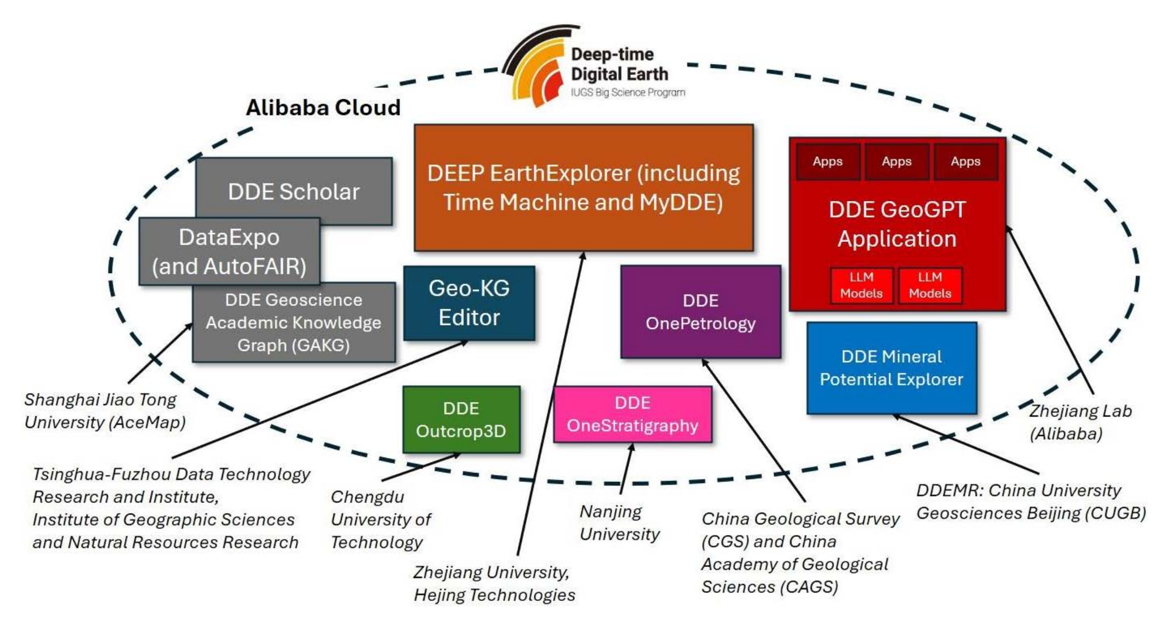

Figure 2. *DDE platform and applications.*

The DDE Science Committee has stated it "*does not view itself as making strategic decisions in digital or science innovation*" (IUGS, 2024b).
The GeoGPT LLM application is described by its developers as an "*open-source non-profit global geoscience research project*" (GeoGPT, 2026e). It is also described as "*equitable*", "*unbiased*", "*trustworthy*", "*responsible*" and "*open, transparent and ethical*" AI, which "*maintains independence from political or commercial influences*" with an emphasis on "*neutrality*", "*fully open-science*" and "*Transparency is at the core of GeoGPT's mission*" (DDE, 2025l; Zhejiang Lab, 2025; GeoGPT, 2026a, 2026c, 2026e; ITU, 2026a).
It is led by a Vice President of a commercial cloud computing vendor (Fan, 2025) who is also a Vice President of the lab that part-owns it (Figure 1). The same

document notes that the Chinese government supplies the fiscal funding, even as GeoGPT's Governance Committee describes the initiative as self-governing, with its own independent framework for governance, technical direction, and financial management (GeoGPT, 2026d).

The application currently offers eight models, six Chinese-origin; the default is based on Alibaba's Qwen 'GeoGPT-R1-Preview' (GeoGPT, 2026c, 2026f) and the vision language model is also based on Alibaba's Qwen (GeoGPT, 2026h). GeoGPT is reported to have been used as a use case for risk mitigation in deep-sea mineral exploration jointly with China's Ministry of Natural Resources (ITU, 2025; Ma et al., 2025). The GeoGPT project has a dedicated organisational structure for oil & gas and minerals (GeoGPT, 2026d, p.6).

GeoGPT was reframed in mid-2026 as a flagship application within Zhejiang Lab's "021 Science Foundation Model" initiative (ITU, 2026b). It extends into satellite imagery with other China-origin geospatial embedding and discipline models and tools, promoted by the GeoGPT Governance Committee in collaborations with Pengcheng Lab and Zhejiang Lab into a 'OneEarth' branded concept (OneEarth, 2025; GeoGPT, 2026d; iEarth, 2026; ITU, 2026a). This is reported to target climate change, climate resilience, and water scarcity (GeoGPT, 2026i).

i) Data openness: the main DDE platform is free to access (DDE, 2026a); core capabilities require user registration and upload of user data to the cloud platform (GeoGPT, 2026a). The platform's terms of service state that "*geoscience data may constitute national secrets*" (DDE, 2026g), a classification with potential implications for the portability and cross-border handling of contributed data under the governing jurisdiction (Section 4.2.3).

   The data licensing agreement for the DDE/IUGS branded OnePetrology, supporting mineral resource identification, is structured as a contribution-for-access arrangement (OnePetrology, 2026). The agreement provides for monetary compensation determined "*according to certain rules*" that are not published.

   No documented public APIs can be found to extract data independently from the web platforms. Public API's have been advertised, "*All the DDE services and capabilities of the platform are open to the public in the form of standard API interfaces*" (DDE, 2022b).

   The DDE Scholar (DEEP Literature) application (Zhu et al., 2025), part of the 'Geological Google' stated in DDE's vision (Section 4.1) allows search over 12 million georeferenced public open-access geoscience abstracts. No bulk download capability exists, and the dataset does not appear to be available independent of the platform (DDE, 2026a). As of June 2026, two core datasets could no longer be located on or off the platform. The DDE Geoscience Academic Knowledge Graph (GAKG) (Deng et al., 2021) and the DDE Geoscience Knowledge

Graph (GKG) used by the GeoGPT application (IUGS, 2024a; Zhu et al., 2025). Their unavailability appears difficult to reconcile with the intentions of the founding DDE paper of making data available independent of the platform (Wang et al., 2021).

ii) Software openness: there is no mention of open-source technology strategies in DDE science plans, platform documentation or founding articles (DDE, 2021; Wang et al., 2021; DDE, 2022b). Whilst some DDE tools are open source (OnePetrology, GeoDeepShovel) none of the large core software applications (Earth Explorer (DEEP), Mineral Potential Explorer, and the GeoGPT Application) appear to be open-source (DDE, 2026a). For GeoGPT, only the 'cleaning' technology has been reported as proprietary (Stephenson et al., 2024). The observable release pattern shows variation to this account: released code is confined to the model-agnostic retrieval subsystem (GeoGPT-RAG, under Apache 2.0/MIT licences; GeoGPT, 2025c), and no application-layer source code, prompting, agent code (e.g., MapChat, Ore descriptor), or databases have been released that would enable independent replication of the GeoGPT Application.

4.2.3. AI transparency and explainability

i) Training data and models: three of the eight geoscience fine-tuned LLM models used by the GeoGPT Application have been released open-weight (GeoGPT, 2025a). Notably, all three are of 70B+ scale, requiring workstation or server-class GPU resources to run. The Mixtral-8x7B-based conversational model offered in the application since mid-2024 (IUGS, 2024a) – distinct from the Mistral-7B-based embedding model released within GeoGPT-RAG (Section 4.2.2) – is the smallest variant offered and the only one deployable, quantized, on a single consumer GPU. Both Mixtral 8x7B and Mistral-7B carry Apache-2.0 base licences, which would permit the least restricted release of any GeoGPT model. A conversational fine-tune of Mistral-7B suitable for a RAG application, the same base the project has already fine-tuned for its released embedding model, would run quantized on a standard laptop, hardware of the kind available to under-resourced institutions and individual geoscientists. Nevertheless, the Mixtral-based GeoGPT variant remains unreleased as of July 2026, no small-scale conversational fine-tune has been released, nor has the training data that would enable the community to produce one; the available documentation discloses no rationale for this, and records no question raised by the GeoGPT Governance Committee (GeoGPT, 2025a; GeoGPT, 2026c; GeoGPT, 2026d).

For the Continued Pre-Training (CPT) dataset, a metadata list of 280,000 open-access geoscience training-data articles from a public common-crawl dataset (GeoGPT, 2025a) has been released, a source-level disclosure. However, this falls short of the auditable-training-data standard advanced by the DPGA (Section 2.2) – of which several African governments (such as Nigeria, Ethiopia, Malawi, Rwanda, Sierra Leone, South Africa and Uganda) are members. The non-release (with no privacy or safety rationale evident for withholding) is also not aligned to the international geoscience AI ethics recommendations adopted by African geological societies (Cleverley et al., 2025). International geoscience institutions requested these data in July 2024 in order to systematically assess what technical biases may exist (Section 2.2) (IUGS, 2024a). The non-release conflicts with previous statements from IUGS and DDE leadership where they declared its training database would be made available "*to those who wish to have it*" (Hawkins, 2024) and other public statements on what aspects of GeoGPT are proprietary (Section 4.2.2). In addition, no fine-tuning dataset or documentation appears to be publicly released for GeoGPT-VL-32B the vision model (GeoGPT, 2026h).

Synthetic datasets using Qwen (and other GeoGPT distilled models) have been released for Question and Answering (Q&A) (GeoGPT, 2025a). However, for the actual Supervised Fine Tuning (SFT), GeoGPT was fine-tuned using 89,000 geological Q&A pairs created in 2023 by DDE/Zhejiang Lab (Zhen, 2023; IUGS, 2024a). Zhen (2023) described how these Q&A pairs were produced by students modifying OpenAI's ChatGPT-generated answers, "*our work is mainly based on the ChatGPT framework, handling large volumes of questions and answers, evaluating and revising the answers given*". Geological societies requested this data in July 2024 (IUGS, 2024a); as with the training corpus, it remains a documented non-release. For the third stage of training using Direct Preference Optimisation (DPO) the GeoGPT team state safety-enhanced corpora were applied to "*reduce risky outputs*" (GeoGPT, 2026c).

DDE describes its technology as "*digital public products*" (DDE, 2025m) advancing OneEarth as "*a digital public good*" (DDE, 2026f) and GeoGPT itself as a "*public good*" (GeoGPT, 2026e) including at the "AI for Good" conference run by the ITU, a specialised UN agency. However, none of the released LLM models have an OSI-compliant license, the GeoGPT license reserves commercial use exclusively for Zhejiang Lab and other restrictions (GeoGPT, 2025a). In addition, core AI training data and application code has not been released. This does not appear in alignment with DPGA definitions (Section 2.2) and is discussed further in Section 5.4.

ii) Explainability: the international facing instance of GeoGPT is hosted by Alibaba Cloud in Singapore with a separate instance in Frankfurt for European users (GeoGPT, 2025b), but terms and conditions state they are all subject to the laws of the People's Republic of China (PRC) (GeoGPT, 2026g). In February 2026 Zhejiang Lab published GeoGPT's risk assessment, covering the application and the default model 'GeoGPT-R1-Preview' behaviour (GeoGPT, 2026c, 2026f). The Risk Assessment treats 'GeoGPT' as the hosted application, of which the open-weight models form only part, alongside software modules and prompting within an agentic application (GeoGPT, 2026c). It documents filtering of what is deemed politically sensitive content. The single documented example, listed under both 'regulation risk' and 'harmful content', shows a query including the "*50 cent party*" (GeoGPT, 2026c; Table 30). The unfiltered response (without the safety filter) pointed to mainstream outlets (the New York Times, the Guardian, the Washington Post), Human Rights Watch, Amnesty International, and cited King, Pan and Roberts (2013) – a highly cited peer-reviewed study of Chinese state censorship; those entire responses were replaced wholesale by a refusal. As this refusal is grouped under 'regulatory risk' (not scientific discipline scope), it appears to be in tension with previous DDE assurances that the international facing GeoGPT application "*will not be affected by any state censorship*" (Hawkins, 2024). The rationale stated in the governing documentation is that political content is outside the geoscience domain scope of the tool. The exclusion boundary is defined as follows, "*GeoGPT is not intended for political advocacy, legal interpretation, medical advice, or non-scientific authoritative use*" and "*By deliberately limiting its scope to technical geoscientific applications, GeoGPT inherently avoids engagement with politically sensitive topics, reduces opportunities for misuse in geopolitical contexts*", and "*strengthens compliance with regional regulations*". No list of keywords or training data is released defining how this filter is operationalised (GeoGPT, 2026c). Other formal documentation from GeoGPT states it should also not be used to ask questions that may interact with "*social topics*" (GeoGPT, 2026e).

The GeoGPT Governance committee, whose members serve in personal capacities, stated they did not have an adequate understanding to endorse the risk assessment at this time (GeoGPT, 2026d). The GeoGPT Governance Committee's consensus was to remove this filtering for the international community: "*while sovereign laws should always be followed in the jurisdiction of the user, all of these prompts should receive a quality response*" (p. 12). The GeoGPT Executive Team's response committed only that GeoGPT "*will not arbitrarily block prompts unless they violate sovereign laws*" (p. 13) – dropping the user-jurisdiction qualifier, a discrepancy the Committee did not resolve and cannot enforce. The implications of this filtering are taken up in Section 5.4.

The GeoGPT Risk Assessment states the models are "*further supported by curated training data that excludes politically charged content*" (GeoGPT, 2026c).

The GeoGPT risk assessment states "*If GeoGPT is used or made accessible outside of the PRC, it may run afoul of foreign data protection, intellectual property, or ethical AI regulations.*" The GeoGPT Governance annual report describes anticipated tensions, "*for largely the wrong reasons, GeoGPT will be challenged by its heritage as a Chinese initiative*" (GeoGPT, 2026d).

4.3. Bibliometric study

Based on the criteria used (Section 3.3) there were 536 DDE-acknowledged publications between 2022-2025 (see full list in supplementary information), with over half of publications in paywalled journals. Institutions from a single country rose from 68.4% in 2022 to making up 94.8% of all DDE papers by 2025 (Figure 3). The journal 'Ore Geology Reviews' contains the highest number of DDE submitted papers (n = 31). A synthesis of the results in Section 4 against the analytics framework is shown in the Appendix (Table 1).

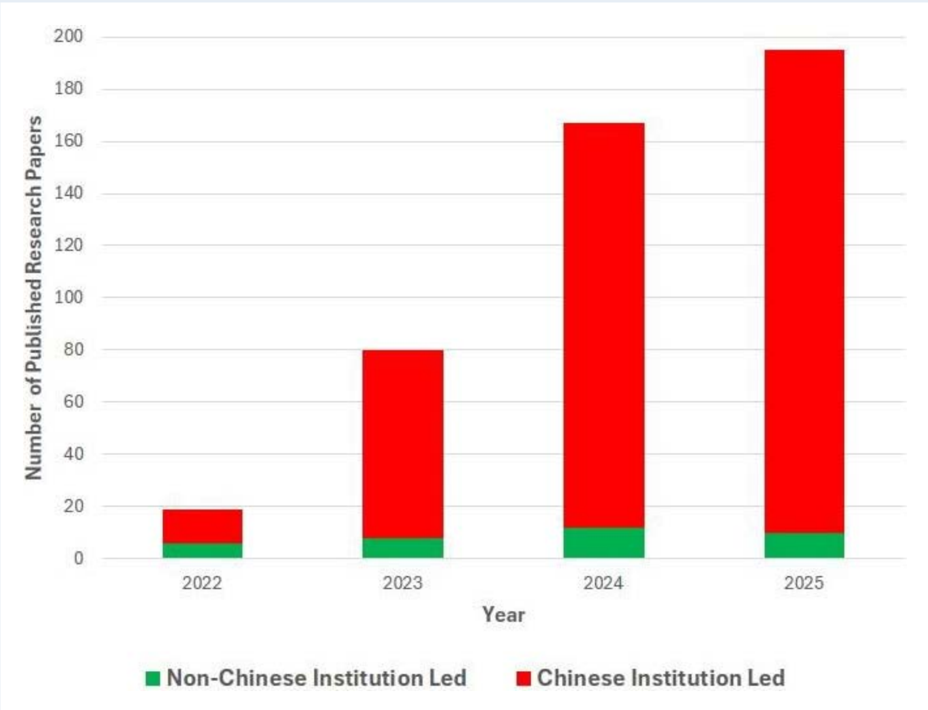

Figure 3. *DDE acknowledged research papers by lead institution.*

5. Discussion

Comparable questions of jurisdictional exposure, strategic dependence, and AI transparency arise across US, European and China-based infrastructures; the analytical focus here follows from the platform's own sustained non-alignment claims, not from national origin (UNESCO, 2021a, 2021b; Xie et al., 2023; The Lancet, 2026). Where the record positively contradicts a framework norm this is stated as such; where it is silent, the claim is only that non-alignment cannot be verified – a finding about institutional conditions, not individual intent.

5.1. Open at the interface closed at the core

This paper does not dispute DDE's technical or scientific outputs; it examines whether the governance conditions under which they are produced permit independent verification of its non-alignment claims.

Across the governance, data, software, and AI layers, openness at the user interface coexists with opacity at points where independent verification would be expected (Appendix; Table 1). This configuration is legible within the UNESCO Open Science Recommendation itself: DDE can plausibly satisfy the Recommendation's functional definition of open science infrastructure, consistent with UNESCO's own description of the programme as supporting open science (UNESCO, 2025b), while the record shows divergence from the community governance and open-source norms the Recommendation attaches to such infrastructures, from its access and reusability expectations where data remains bound to the platform or subject to unpublished contribution terms (Section 4.2.2), and from the transparency provisions of the UNESCO AI Ethics Recommendation (Section 4.2.3).

This configuration reflects a broader structural reinterpretation, where the globalisation era's open-science commitments are increasingly balanced against a control and security-inflected reading of the long-standing '*as open as possible, as closed as necessary*' formula documented by Turekian and Gluckman (2024) and invoked by DDE itself (DDE, 2025a).

5.2. Governance and context

Sole-source funding is a structural precondition for the resource domination that impacts autonomy (Gläser et al., 2022), though this alone isn't evidence that domination determines outcomes – it could reflect donor scarcity, as DDE itself suggests (DDE, 2024b). Following Abbott and Snidal (1998) and Barnett and Finnemore (2004), the relevant question is what that concentration structurally produces. DDE governing bodies still have not clarified the platform's ownership structure several years into operation (DDE, 2025e).

DDE's governance documentation is silent on numerous strategic and technology decisions (Section 4.2.1(iii)). At least two explanations remain consistent with the documentary record: the Governing Council and Executive Committee may exercise independent strategic authority that is not captured in public records, or their documented role may primarily reflect formal endorsement rather than active policy formulation, leaving the operational locus of strategy unclear. The available evidence does not permit the distinction. What it does establish is that operational, technical, and funding authority sit within a small set of interconnected actors (Figure 1); whether that concentration translates into decision-making authority cannot be assessed from the available evidence.

Whether the state-appointed General Expert Group, which co-adopted the DDE strategy including GeoGPT promotion (Section 4.2.1(iii)), bounds the Governing Council's authority likewise cannot be determined from the record. This could be benign but is also the configuration Barnett and Finnemore (2004) associate with asymmetric donor influence over international organisations.

The high concentration of single-country institutional lead authorship (Section 4.3) indicates internationalisation has not yet produced observable diversification. The prominence of 'ore geology' in the bibliometric record is consistent with the document analysis (Section 4.2) which also highlights the strategic nature of oil & gas resources in DDE/GeoGPT activities.

The DDE-CADFund agreement interfaces an organisation (Section 4.2.1(iv)) claiming political non-alignment with a political investment vehicle dedicated to a single nation's commercial activity and foreign policy. The programme's documentation does not clearly delineate where scientific collaboration ends, and bilateral development finance begins. A similar pattern appears in recruitment, where DDE targets prioritise visiting-scholar activity to BRI-participating countries (Section 4.2.1(i)) complicating its declared status as geopolitically unaligned.

A related ambiguity surrounds nationally governed entities incorporated into outward-facing descriptions of the programme (Section 4.2.1(iv)): key leaders hold overlapping roles across nationally and internationally directed organisations under the same 'DDE' brand, making the components difficult to distinguish. Institutions conducting 'knowledge diplomacy' (Section 2.1) for national interests and mutual benefit simultaneously is not itself unusual; it becomes a verifiability problem only under a claim of geopolitical non-alignment.

Members of DDE/GeoGPT governing bodies are also beneficiaries of funding from the same actor network (Section 4.2.1(ii); DDE, 2025h, 2025i) – not disqualifying in itself, but here that dependence derives from a single state-linked source. Where the EU-funded Human Brain Project responded to external scrutiny with reforms strengthening independent oversight (Marquardt, 2015), DDE/GeoGPT's documented changes appear to have instead shifted their network of international scientists further away from oversight toward advisory and promotional roles.

The GeoGPT Governance Committee is a genuine point in the platform's favour and represents a shift towards international dialogue. Such international advisory structures remain uncommon in domain-specific AI and the participation of respected international geoscientists may strengthen the platform's legitimacy. However, its independence is deliberative, not structural: appointments, funding, and charter amendments remain subject to approval by Zhejiang Lab's Executive Team (Section 4.2.2). The international GeoGPT committee holds no audit, investigative, or approval rights, and its recommendations are non-binding. Consequently, the continued use of terms like 'governance' and 'oversight' following the February 2026 Terms of Reference amendments presents a conceptual variance, given that the formal documents outline an advisory capacity only, rather than binding executive or operational authority.

5.3. State-anchored international platform

A non-alignment claim made to African partners (Section 4.2.1(iv); GSAf, 2023) coexists in the record with framings that situate the programme within national resource-security and great-power-competition objectives (Section 4.2.1(iv)). The coexistence of these dual objectives suggests that external participants may find it difficult to ascertain which framework primarily drives platform priorities. This internal complexity is somewhat mirrored in the programme's own SWOT analysis, which balances non-alignment as a strength while recording perceived dominance, and funding concentration as weaknesses (Section 4.2.1(iv)).

On the basis of the evidence reviewed, DDE/GeoGPT is best characterised as a state-anchored international platform. This is a descriptive category for infrastructures combining international participation with substantial dependence on a single national jurisdiction, irrespective of which state is involved. The corporate-state relationships in Figure 1, with technology and resource-extraction firms alongside state bodies in governance, place it within the polylateral configuration of tech diplomacy described by Bjola and Kornprobst (2025); the neutrality claim itself is also readable through Huang and Meng's (2025) discourse power, whereby claims about technological norms legitimise particular governance arrangements.

The analytical issue is not that the host nation derives benefits, a common feature of science diplomacy (Gluckman et al., 2017; Ruffini, 2020). It is that the platform claims geopolitical non-alignment while the institutional conditions required for independent verification are not yet in place – a claim, and a closure, that established geoscience data infrastructures do not combine. DDE/GeoGPT is conceptually analogous to EarthCube (Section 2.3) – both fund domestic institutions to build the technology – but EarthCube made no non-alignment claim (EarthCube, 2019), whereas DDE/GeoGPT does so while funding and paying the expenses of international scientists.

Even stronger governance arrangements would be unlikely to resolve underlying jurisdictional issues: the platform's terms place it under PRC law, including the National Intelligence and Data Security Laws, regardless of where it is hosted or accessed. This is not a claim unique to China – US providers operate under the CLOUD Act, European and other jurisdictions have their equivalents, so jurisdictional anchoring is comparable in kind. What distinguishes the present case is not the exposure, which is universal, but the claim attached to it: among these infrastructures, only DDE/GeoGPT couples single-jurisdiction anchoring with an assertion of geopolitical non-alignment (Section 2.3).

Where a non-alignment claim is made, deployment optionality becomes decisive. An exemplar (Appendix, Table 1) can be deployed under a jurisdiction of participants' choosing, so no single nation can compel their behaviour. From the evidence, DDE/GeoGPT platforms, by contrast, appear proprietary so by inference, are unable to be independently replicated or governed outside their originating jurisdiction – a constraint the GeoGPT risk assessment itself acknowledges may already conflict with foreign regulation (Section 4.2.3). Following Birch (2025), this jurisdictional condition is not an external constraint on an otherwise unaligned platform but constitutive of how it operates – one no participation agreement alters.

5.4. AI transparency, explainability and epistemic sovereignty

The release of open-weight models is a useful contribution to the community. The absence of application-layer code, prompting, agents, datasets, or pipelines however, (Section 4.2.2) is difficult to reconcile with the open-source framing for the GeoGPT application. 'Open' here refers primarily to free access and open weights, which permit adaptation and redeployment but not inspection of training data or independent reproduction (Widder et al., 2024).

Under the Model Openness Framework (MOF) recommended by the UN University (UNU, 2026), OLMo (Section 2.2) would attain Class I (Open Science), Earth Virtual

Expert (EVE) interpreted as Class ~II (Open Tooling) and Mistral-7B / Mixtral 8x7B as Class III (Open Model). The GeoGPT released models would attain no MOF class because they have non OSI-compliant licences with restrictions and have withheld AI training datasets, so can only be described as an 'open-weight', source-available release, *not open*. A description Meta's Llama models share, despite both teams describing their releases as open-source (Liesenfeld and Dingemanse, 2024).

Because neither training set documented in Section 4.2.3 has been released, reproducibility and bias estimation in GeoGPT cannot presently be carried out independently (Mitchell et al., 2019). These findings also bear on GeoGPT's self-description as a technological 'public good' (Section 4.2.2). Like non-alignment, these are trust-soliciting claims, yet transparency is both the platform's own declared standard and the precondition for verifying them, since bias and equity remain difficult to evaluate independently without the undisclosed training data, filtering criteria, and pipelines (Sections 4.2.2-4.2.3). Rather than evaluating underlying motivations, this architectural critique emphasises that without full disclosure, the practical application of ethical standards remains difficult to independently verify, underscoring why structural auditability is vital to establishing framework compliance. The UNU assessment of AI systems as digital public goods reaches the same conclusion, warning against premature public-good claims (UNU, 2026).

Zhejiang Lab's publication of a governance report and risk assessment discloses more than most comparable platforms, and this analysis relies on it (GeoGPT, 2026c). A safety classifier of some kind is common to hosted models. What is at issue here is narrower and not a standard feature, the filtering of peer-reviewed material that the platform documentation identifies as politically sensitive under China's regulatory framework and norms (Section 4.2.3(ii)). This therefore becomes a question of alignment because both the GeoGPT Team at Zhejiang Lab and the DDE initiative that promotes it internationally advance political non-alignment claims (GSAf, 2023; GeoGPT, 2026a).

At the application layer, the criteria, keyword scope, and working definition of '*social*' or "*politically charged content*" are undisclosed, leaving the filter's effect un-auditable; GeoGPT documentation justifies this as outside the 'geoscience domain', although this is contradicted with the same example also placed under 'regulation risk'. This configuration invites further evaluation given that geoscientific research is frequently situated within broader political and social contexts (Section 2.1).

At the corpus layer, political filtering is also present (Section 4.2.3(ii)), and the chosen default model's base is of a type reported to carry sensitive-topic filtering and ideological alignment in its weights (Section 2.2). Model plurality at the point of user selection may therefore not be fully sufficient, on its own, to demonstrate neutrality if underlying filtering mechanisms operate independently of model choice – and given evolving regulatory requirements, these boundaries need continuous rather than one-off scrutiny (King et al., 2014; Pan and Xu, 2026).

The Committee-Executive exchange (Section 4.2.3(ii)) does not clarify whether filtering of peer-reviewed literature will continue, and whether the domain ringfence is a scientific decision or a regulatory one; the public documentation leaves this unresolved. The claim in Section 4.2.3(ii) presupposes that criticism of GeoGPT's origins is primarily geopolitical; the issue tested here is transparency and independent oversight, not provenance (Section 5).

5.5. The practical dilemma for African geoscience institutions

The Africa Mining Vision, Pan-African Parliament (2025), and Effoduh (2026) have each set out conditions when engagement with external platforms serves rather than undermines data sovereignty; the dilemma identified here operates within that framework.

Current alternatives to DDE/GeoGPT are not a better-governed platform of equivalent design. Frontier free-to-use general-purpose LLMs offer similar, often more advanced, capabilities under geoscience domain prompting, yet share comparable opacity and jurisdictional exposure. Remotely hosted platforms, including DDE, produce benefits for visualising, accessing, and querying geoscience data (Section 4.2.2).

DDE and GeoGPT are framed as shifting agency and capacity toward African institutions (Section 4.2.1(iv)), but given the jurisdictional condition established in Section 5.3, participation may build operational competence within the platform more readily than transferable governance or technical capacity: agency exists at the level of use, not governance (Section 4.2.3). This is the condition the UN Scientific Panel identifies as access without practical control (Section 2.4). As institutions invest in platform-specific tools and agents, the cost of exit rises – a dependence that sits uneasily with the sovereign capacity-building objectives of the Africa Mining Vision (Busia and Akong, 2017).

The GeoGPT release pattern compounds that dependence. No core training data or application-layer source code has been released (Sections 4.2.2-4.2.3), and open weights exist only at scales requiring inference compute largely absent from many African institutional settings and individual geoscientists (IISP, 2026; UNU, 2026), for whom cost-free access matters most (UNU, 2026). The one GeoGPT model deployable on consumer hardware remains unreleased (Section 4.2.3(i)). In practice, 'open' access therefore resolves back to the hosted platform, precisely the dependence the DDE/GeoGPT openness claim implies users can escape, and a configuration difficult to reconcile with the platform's self-description as "*equitable*" (Section 4.2.2).

Promoting the platform to African governments for evaluating foreign investment proposals, while key advisory structures maintain close institutional links to a specific national resource-extraction sector, highlights an alignment of interests that may complicate claims of geopolitical independence. This is independent of data access; these roles can shape a platform's design and framing regardless of confidentiality safeguards.

Participation in DDE/GeoGPT does not imply a common interpretation of its neutrality claims – some participants may accept them at face value, others may regard them as secondary to practical benefit; others may participate only on the assumption they are true. Participation alone cannot establish that the claims have been audited. Nor can positive testimony from within the funded network however sincere; independence from the funder is a condition under examination (Section 2.1), which is why the framework rests on externally auditable conditions rather than testimony (Section 3.2).

These findings suggest due diligence should extend beyond platform governance to the framing of engagement itself, assessing capacity-building claims against the structural conditions that actually enable control, auditability, and data retention. These are considerations consistent with the CARE Principles (Carroll et al., 2020), the African Union Digital Transformation Strategy (AU, 2020), and emerging data-sovereignty initiatives (AU, 2022). The broader gap – an absence of independent mechanisms for evaluating alignment claims in AI-enabled infrastructure – falls disproportionately on institutions least able to absorb its consequences; the criteria developed here offer a potential transferable basis for closing that gap.

For capacity-building programmes, this points toward open-source, locally deployable workflows that preserve operational control, reserving calibrated engagement with foreign platforms for contexts where data sovereignty is less critical, and diversifying partnerships and multiple points of access. Regional sovereign or federated cloud architectures offer one path to reducing single-jurisdiction dependence while preserving international collaboration.

6. Conclusion

Based on the evidence presented, DDE/GeoGPT is best characterised as a state-anchored international platform whose asserted geopolitical non-alignment cannot presently be independently verified through either technical or governance pathways.

For African institutions the dilemma is structural: where knowledge production operates under jurisdictional conditions participation agreements cannot override, epistemic sovereignty faces assurance challenges, unless governance, training, and filtering processes are transparent enough for external evaluation. Emerging African compute, open-source, and nationally governed alternatives suggest this is primarily a question of investment and institutional capacity rather than technological constraint.

The three criteria offer a transferable baseline for evaluating non-alignment and ethics claims in AI-enabled scientific infrastructure. Further research could operationalise them into structured instruments analogous to AI model cards (Mitchell et al., 2019), enabling continuous evaluation of governance independence, data openness, and AI transparency beyond this case, a need for independent assessment infrastructure the UN Scientific Panel has identified as generic to the field.

Science diplomacy can support dialogue, partnership-building, and multilateral engagement toward the SDGs – but credibility is difficult to sustain where a significant gap persists between what a platform communicates to the geoscience community and the reality of its governance and artefacts. That gap can be narrowed either by aligning public claims with the record currently available or by adopting the disclosure and governance measures outlined here. Independently verifiable non-alignment is difficult to sustain where a platform's core artefacts remain closed, subject to the law of a single jurisdiction, and their provenance cannot be independently examined.

Beyond this case, the contribution of this study is to reframe geopolitical alignment in cyberinfrastructures as an empirically auditable property rather than a declarative claim. The proposed framework provides a transferable basis for evaluating governance, data openness, AI transparency, and neutrality claims across AI-enabled scientific infrastructures, irrespective of jurisdiction.

The paper contributes to an emerging debate on how such claims should be evaluated rather than offering a final judgement, and the authors welcome replies from DDE/GeoGPT, and other parties. As scientific AI becomes increasingly embedded in international research infrastructures, maintaining trust will depend less on institutional assurances than on governance and technical arrangements that enable independent verification.

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Appendix

Table 1 summarises the key governance, data, software, and AI transparency tendencies identified across the document analysis compared to the analytical framework – 'what good looks like' in this context. Characteristics are made against the standards DDE's/GeoGPT's own geopolitical non-alignment claims invite; exemplars are added to illustrate supporting norms from the analytical framework.

Key Findings	Norms from Analytical Framework – tendencies an exemplar model would exhibit	Verification tendencies (based on the case's own claim)
	Criteria: **GOVERNANCE INDEPENDENCE**	
Funding: Direct to national DDE Zhejiang Center for digital platform infrastructure (DDE, 2025e;2025f). No independent finance committee/trust. Overlapping funding relationships in GC (DDE, 2025h; DDE, 2025i). Some investment / recruitment targets tied to Belt and Road Initiative (DDE, 2024b).	Multilateral, transparent, independently controlled platform funding. (UNESCO, 2021a, 2021b; Gläser et al., 2022; ISC, 2024). *Such as CERN, Human Genome Project, OneGeology and GEO.*	**Inconsistent evidence in the public record**
Ownership: Data/technology platform and application ownership, and licensing strategy unclear (DDE, 2026d).	Transparent technology ownership and clear licensing. (UNESCO, 2021b; ISC, 2024). *Such as OneGeology, CERN, Human Genome Project, GEO (GEO rules dictate that any data, software, or products developed within a GEO Work Programme activity must be made available to the public under an open license).*	**Not disclosed in available materials**
Independent decisions: Deliberation processes not publicly documented. (DDE, 2025d; DDE, 2025e; DDE, 2025i; DDE, 2026b; DDE, 2026c). Statement from science committee [Section 4.2.2] indicates no role in digital platform. DDE strategic framework co-adopted by sponsor appointed body (DDE, 2025a, 2025d, 2025k). GeoGPT GC Committee appointed by Zhejiang Lab; changed from oversight to advisory role. (GeoGPT, 2026b).	Multilateral Independent Strategic decision-making for technology platform. (Ostrom, 1990; Barnett and Finnemore, 2004; ISC, 2024). *Such as OneGeology, Human Brain Project (post review), GEO (Rules of Procedure (GEO, 2025)).*	**Inconsistent evidence in the public record**
Arms-length commercial relationships: DDE signed agreement with a commercial state investment fund (CADFund) (NJU, 2026). Apparent overlap in the public record with the state-resource extraction sector (NEPU, 2024; DDE, 2025g; GeoGPT, 2026d).	Arms-length commercial relationships. (UNESCO, 2021b; ISC, 2024; GEO Rules of Procedure, Annex C, Rules 2.4, 2.6, 2.8-2.9). *Such as OneGeology, GEO.*	**Inconsistent evidence in the public record**

Key Findings	Norms from Analytical Framework – tendencies an exemplar model would exhibit	Verification tendencies (based on the case's own claim)
Criteria: **DATA AND SOFTWARE OPENNESS**		
Access: Platform free to access. Data not consistently available independent of the platform (e.g., DDE Scholar 12 million items, OnePetrology contribution access terms), however on balance the tendency is towards open access with caveats.	Freely accessible, reusable, portable data (Wilkinson et al., 2016; UNESCO, 2021a). *Such as OneGeology, Human Genome Project (data made available independent of technology platforms)*	**Partly verified at the interface level (data not fully portable outside the platform risking lock-in)**
Deployment: The core DDE Platform itself and all core applications (including Earth Explorer, Mineral Potential Explorer GeoGPT application-layer including agentic modules like MapChat and Taxonomy Assistant) are not released open-source so it is not possible to inspect them (DDE, 2022b; DDE, 2021; GeoGPT, 2025a).	Open-source, independently deployable (encouraged by UNESCO) (UNESCO, 2021a; ISC, 2024). *Such as OneGeology (CeCILL v2.1 is an OSI-approved open-source licence), GEO, CyVerse (OSI Compliant)*	**Inconsistent evidence in the public record**
Criteria: **AI TRANSPARENCY AND EXPLAINABILITY**		
Model and Training data: No evidence found that any core AI training sets are released in full (IUGS, 2024a). Three of the eight LLM models used in GeoGPT have been released open-weight but are not 'open' as defined in the Model Openness Framework (MOF) advanced by the United Nations University and have non OSI-compliant licenses.	Auditable Training data (Mitchell et al., 2019; UNESCO, 2021b; Cleverley et al., 2025). *Such as OLMo* (MOF Class I – Open Science)*, EVE* (MOF Class II – Open Tooling) and OLMOEarth*.*	**Inconsistent evidence in the public record**
Algorithmic Safety filters: Content filtering is standard across AI platforms, but filtering that turns on whether an answer reflects poorly on a particular state is not a normal feature of research tools. GeoGPT's criteria for operationalising such filtering are undisclosed and therefore cannot currently be inspected (GeoGPT, 2026c). This is difficult to reconcile with the project's open-science commitments, and it is unclear whether the UNESCO (UN) IDSSD endorsement process, which assesses applications submitted by the applicant, properly examined these characteristics.	No censorship (outside those safety areas described in the UN declaration of Human Rights) in platforms affiliated, endorsed or approved by international scientific organisations. (UNESCO, 2021a, 2021b; Cleverley et al., 2025). *Such as OLMo*.*	**Contradictory and ambiguous evidence in the public record**

(*) OLMo, OLMoEarth and EVE are neither open-participation international projects nor claimants of geopolitical neutrality; they are cited solely as exemplars of the properties the framework tests: inspectable open-source AI with training data for reproducibility.

Table 1. *Characterisation of geopolitical non-alignment against the analytical framework.*

*Corresponding author: **P.H. Cleverley**

e-mail: paulhughcleverley@gmail.com