Testimony of Mr. Daniel Donahue, Head of Growth at Terra AI

Hearing on Unleashing American Energy Dominance and Exploring New Frontiers

Natural Resources Committee, Oversight and Investigations Subcommittee

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1. BACKGROUND

Terra AI, an industry-leading software company backed by Khosla Ventures and Rio Tinto, headquartered in Redwood City, California, develops and applies AI to model subsurface critical resources and to optimize exploration to drastically accelerate and improve resource development. We screen new mineral discoveries more effectively to improve "economic false positives" from today's 90% rate to under 50%. Our optimized drill planning characterizes resources faster, with 40% fewer exploratory drill holes than traditional methods, and increasing the output of producing assets via improved geologic knowledge. We produce more insights from less data. We are moving very fast to transform resource exploration and development from a legacy practice into a data-driven industry, delivering scientific firsts on a monthly basis, and building a great American AI company for our critical subsurface resources.

I am Danny Donahue, the Head of Growth at Terra AI. I have a degree in geoscience from Williams College and previous experience in finance and technology. I am responsible at Terra AI for partnerships with the world's largest miners, like BHP and Rio Tinto, medium sized firms like Wyoming's Ramaco Resources, large energy companies like OMV and Petrobras, national governments, and other leading technology providers.

Terra AI was founded 2 years ago by John Mern, PhD, Anthony Corso, PhD and Professor Markus Zechner, who are AI and geoscience alumni from Stanford. They combined their decades of research and careers in AI, energy, and defense to produce a suite of brand new innovations for the natural resources sector. We are one of the only places in the world where AI engineers from Meta, Google, and Stanford work next to geologists from Shell, NASA, Schlumberger, and the Colorado School of Mines.

2. THE TERRA AI MISSION

Terra AI is innovating to respond to our growing national imperative for mineral exploration. The world's key industries are driving a 4-6x increase in metals demand over 15 years [1], but we are not finding metal fast enough to keep up.

A. **ENERGY:** New energy needs, electrification and grid buildout will require 600+ new large metals mines, more than exist today in the US, Canada and Europe combined. [2]

B. **AI:** Each 1 gigawatt of data center capacity requires 27,000 tons of copper (2.5% of America's output), 80 tons of silver (7%), 30 tons of gold (17%), 760 tons of barium (33%) and many more metals like rare earth elements, antimony, niobium and tungsten that we currently do not produce any of. [3] In many cases, this is the equivalent to the entire annual output of a small to medium mine. These numbers represent only the datacenter and do not include power and infrastructure upgrades. Hyperscalers like Anthropic are expecting an expansion to 50GW of such datacenters in the next decade alone.[4] If we want to control our AI future, we must control its critical inputs.

C. **SUPPLY CHAIN RESILIENCY:** The US must also account for the fact that today's base mineral supply is dominated by potential adversaries – China dominates global critical minerals mining and sends ore output to China for refinement and processing, dominating 65% to 90% of the global supply of key commodities. [5] Mines not directly controlled by China are often controlled by nations reliant on Chinese supply chains and financing. To a more limited extent, Russia wields market power over some strategic commodities such as Palladium, Titanium, and Uranium.[6] The futures of our aerospace, defense, auto manufacturing, pharmaceuticals and other key industries are at risk from upstream bottlenecks and potential adversary action.

Each of our major manufacturing, energy and supply chain drivers is downstream of a mining exploration bottleneck that today takes 15+ years between discovery and first production, while demand is growing at AI speed and scale. The market is failing to react quickly enough under the status quo due to lack of investment and long lead times. If we do not accelerate exploration now, it will be too late.

A. Today, we are falling short. Majors like BHP are concerned over "the looming global copper supply challenge, existing copper mines aging, and the pipeline of potential projects less healthy than in previous cycles." [7] If all the world's funded and announced new mines are fully built, we could still be looking at 10-40% supply gaps by 2035 [8] across a list of big and small metals markets. Bringing new deposits online is critical.

B. Western exploration is the backbone of new mineral supply. Small publicly-listed firms based in the United States, Canada, Australia, and South Africa, known as juniors, make approximately 70% of discoveries. [9] They account for about ~50% of all grassroots exploration spend. [10]

C. Explorers advancing new discoveries into advanced drilling typically realize a <90% false positive rate - meaning 9 of 10 extensively drilled targets never produce an economically viable mineral resource. [11] Most deposits are ultimately sub-economic, but explorers will spend, in an ideal world with no delays, roughly $25M to test economic viability. [12] In many cases, these expensive tests still produce inaccurate results. For instance, 80% of feasibility studies, conducted at the end of this process before construction, are wrong by more than 20%. [13] The ratio of good money to bad money spent in the exploration industry is approximately 4:1.[14] Geologic uncertainty is the most significant contributing factor to these problems. Identifying winners earlier and making this process more efficient is a problem made for AI to solve.

D. Today, in this critical yet highly technical space, winners are hard to distinguish from losers. Exploration lead times have become too long (particularly in the US) to be attractive to large mining companies, known as majors, so their role has become the final buyer, similar to large pharmaceutical companies. These same lead times, along with <$50M investment requirements (below the investment threshold for many major mining investment institutions), and specialized diligence requirements similarly make exploration unattractive to the larger institutional investors (like private equity) that could support the expensive stages of advanced exploration. So, most exploration is funded by a small-scale, highly fractured professional investment ecosystem and many retail investors.

E. This speculative system is breaking down– discoveries of new copper, for instance, are down 80% since 1990, [15] while times to convert discoveries into mines have shot up from 6 to 18+ years. [16] The discovery cost per unit metal has increased 20x for copper, 17x for gold, 16x for zinc between the 1990s and 2010s. [17] Those numbers are trending worse, as a function of increasing scarcity, permitting, a challenging investment ecosystem, and, critically, remaining economic resources moving deeper underground and becoming more geologically complex.

F. This decline in exploration success is leading to upward price pressure and decreasing new supply of critical commodities underpinning America's national security and economy. If we do not find new metals, we will have to make tough either/or decisions about major national priorities and supply chain security.

Our national rivals are benefitting from the West's dominant exploration industry by applying state largesse to capture early stage deposits that our market-based approach is failing to move forward fast enough. They are, however, not meaningfully innovating in this segment.

A. China's domestic mineral endowment is not enough to supply their critical industries. Chinese companies are significant buyers of early-stage Western exploration assets abroad with elevated, early-stage geologic risk, because they have a whole-of-economy view of new mineral supply. State-backed Chinese companies are frequently vertically and horizontally integrated all the way from mine to manufacturer, bringing together the investment, expertise, and private and public stakeholders required to accelerate development.

B. In contrast, the Western mining industries exploration and development pipeline and capital markets are fragmented between explorer, developer, and manufacturer, often leading to extended financing and development delays. Chinese companies can therefore easily succeed in buying and developing early-stage strategic mining assets through state-backed loans, along with a higher tolerance for initial lossmaking, lower environmental and community standards, and a lower cost of refining and extraction.

C. However, while Chinese miners benefit, it is more often junior Western companies who do the exploration work. Western companies have discovered and continue to discover all of the great deposits of the world. In this sense, an absence of greater western strategic support for exploration has allowed Chinese interests to capture strategic supply initially funded by Western household investors and companies.

D. Furthermore, the mining technology and innovation ecosystem of the West does not have a parallel anywhere else in the world. By leveraging its advantages in technology and innovation, the West can significantly accelerate the development of strategic resources, and make investment in exploration and mining significantly more attractive to retail and strategic investors alike.

3. TERRA AI'S TECHNOLOGY

The United States and allies have an opportunity to leapfrog our rivals and dominate the deposits of the future by leveraging our asymmetric technical innovation advantage into a national offset strategy. A combination of recent advancements in artificial intelligence has opened up an opportunity to accelerate the way we screen, model and explore new resources.

A. **STATUS QUO:** Traditional resource modeling is a statistical practice developed 50-60 [18] years ago with few updates that results in one or several geologic models based exclusively on drilling, not geophysics. These models are often wrong: 80% of late-stage pre-construction feasibility studies are wrong by more than 20%. [19] This disparity is due to the greatest uncertainty in mining– subsurface geology. Mining explorers and developers attempt to deterministically characterize subsurface resources sufficiently to underwrite large investment decisions based on the true measurement of <1% of the resource.

B. **TERRA AI:** Terra AI has produced a wholly new approach to exploration and development that rapidly accelerates knowledge gain and adds confidence levels to high-cost mining decisions, built off of two key innovations that have occurred over the past five years in Silicon Valley.

a. **GENERATIVE AI:** At Terra, we build AI systems that understand how geology actually forms. They are able to create full geologic models that a human would take weeks or months to make using AI methods similar to those used in drug discovery to build systems that understand physical reality. These geologic models match priorly collected drilling and geophysics data of our clients and are generated by the 1000s to show all the variable geologic systems that "could be there". These models, in the aggregate, are summarized to result in predictions of uncertainty and probability distributions over key parameters– the likely size or grade of a deposit or where in 3D space there is the most uncertainty. This confidence gives an objective measure of geologic, financial, and operational risk to operators at every stage of mineral development.

b. **DECISION OPTIMIZATION:** Terra AI has further applied decision-optimization techniques from the self-driving and superhuman game-playing fields to make better exploration decisions under uncertainty. These algorithms simulate millions of possible sequences of drills over thousands of possible geologies to arrive at the drill decisions that best match our clients' desired strategies.

C. We have seen applications of our technology in the field yield significant results for clients. Deposits can be screened more effectively with lower false positive rates from 90% today to 20 - 50% with Terra. Resources have been measured with 40% fewer drills than traditional methods.

Terra AI will transform American mining by reducing uncertainty and dramatically speeding up exploration and investment. America and allied nations will be able to win the deposits of the future, which will lead to significant positive changes to the quality, cost, and availability of minerals for our critical industries. With innovation in exploration, America can succeed in AI, energy, manufacturing and GDP growth goals.

A. **PLENTIFUL AND ELASTIC SUPPLY:** Currently, when demand rises for a mineral, prices shoot up, exploration and development get funded and, over a 10-15 year period, new supply is explored and brought online. This delay leads to significant value

destruction. If we can (1) predict uncertainty, (2) speed up development timelines and (3) pick winners earlier, we will see a more elastic supply to meet our needs faster and cheaper. When industries experience lower prices and more plentiful metals, innovation occurs in materials science, robotics, pharmaceuticals, chemicals and more. Improving exploration will improve America's downstream industries.

B. **GREATER PRIVATE INVESTMENT:** If we are able to shrink development timelines and lower risk earlier, more professional investment will come to earlier stages of mineral exploration. Less money and time will be wasted on the development of sub-economic assets. Projects will be financed earlier and require less drilling to achieve resource certainty. The average *successful* exploration project has an IRR of 44%, [20] which is attractive. However, at nearly 15-20 years, [21] the United States has some of the longest exploration timelines in the world. Shortening this by many years and lowering attrition rates will lower investment risk, bring in new investors to the space, and raise the value of the American mining industry to investors and create new jobs.

C. **MINERAL DOMINANCE:** While our rivals are succeeding through state largesse, lower operating standards, and higher risk tolerance, they still must contend with traditional resource modeling, long timelines, and many deposits being economically sub-par. The US and our allies have the capability to get involved earlier, better, and faster at a stage where the check sizes are small relative to mine construction finance, investments are highly levered in terms of attracting more abundant downstream private capital, and the gap between market performance and strategic needs are the largest.

D. **COMMUNITY BENEFITS:** At the community or district level, AI-driven exploration will have positive impacts.
    a. AI can make non-direct exploration like geophysics surveys more effective.
    b. AI can increase the likelihood of success for permitted exploration activity.
    c. AI can drive an accelerated return to the community with faster development.
    d. AI can find things that humans missed and potentially re-open old mines.

4. DEPLOYMENTS

Our technology has been tested and validated in the field across many commodities and systems. While we cannot speak publicly about many engagements, and much of our work is overseas, some of our domestic work has occurred with the following companies and places.

- The Ramaco Resources Brook Mine in Sheridan, Wyoming
- Reevaluating historic inactive copper mines in Arizona

4. POLICY RECOMMENDATIONS AND SUPPORT

We support policy changes which will allow for safe, more efficient and predictable permitting of critical resource exploration. Even if our technology is applied at scale in the United States, American miners and explorers will still struggle to explore, finance and develop mines if permitting issues create decadal to indefinite delays on projects. In the same way, even if permitting reform occurs, American miners and explorers still need to attract capital, lower uncertainty and meet our huge mineral needs faster and better than they do today. These priorities are intertwined in unleashing America's energy and mineral dominance.

Terra AI further supports policies that require the open-source publication of geologic and geophysical exploration data after a pre-competitive lock-up period for the original collectors / explorers. US allies, including Australia, have pioneered and deployed this practice at scale. Several years after an initial explorer departs an area, the generated data is returned to the public domain, allowing other companies to take a second look with the benefit of historic data. Due to the highly heuristic nature of exploration historically and rising resource scarcity and prices, this has been one of the most common trajectories behind major resource discoveries. Transparency requirements have served to bolster Australia's national geoscience dataset and support Australia's world-class exploration and mining ecosystem. Today, the US has no such requirement, and much of the great data collected over the years is private or long lost.

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