# When Neutral Atoms Meet Rare Earths

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## Key Takeaways

- USA Rare Earth, Pasqal and Riven Systems are partnering to develop rare earth separation technology using quantum machine learning as the discovery engine.
- Pasqal will benchmark quantum machine learning against classical models to identify extractant candidates that may bind more selectively to individual rare earth elements.
- The early-stage collaboration connects two distinct WisdomTree themes through the WisdomTree Quantum Computing Fund (WQTM) and WisdomTree Efficient Rare Earth Plus Strategic Metals Fund (WDIG).

*What the Pasqal–USA Rare Earth Partnership Signals*

On September 17, 2026, three companies working on opposite ends of the periodic table announced they would work together.1

- USA Rare Earth2
- Pasqal3
- Riven Systems4

They formed a strategic partnership to develop next-generation separation technology for rare earth elements, using quantum machine learning as the discovery engine.

For WisdomTree, this announcement sits at a genuinely unusual intersection. We have direct exposure to Pasqal, through the WisdomTree Quantum Computing Fund (WQTM), and USA Rare Earth, through the WisdomTree Efficient Rare Earth Plus Strategic Metals Fund (WDIG). It is rare that a single piece of corporate news touches two distinct thematic strategies at once, and rarer still that it does so in a way that concretely illustrates how one emerging technology (quantum computing) might accelerate progress in an entirely different strategic sector (critical minerals).

## What Was Announced

USA Rare Earth, Pasqal and Riven Systems, a New York-based specialist in AI for industrial chemistry, will jointly pursue new separation chemistry for the rare earth value chain. The stated goal is to identify molecules that bind more selectively to individual rare earth elements than the chemicals used today, with the aim of enabling processing facilities that are smaller, cheaper and less energy-intensive than

current designs. The work will be tailored to USA Rare Earth's own feedstocks, including material from its Round Top deposit in Sierra Blanca, Texas, along with third-party mixed rare earth carbonates and recycled magnet-manufacturing scrap.

## Why These Firms and Why Now

The timing is not coincidental. Rare earth separation is one of the more stubborn bottlenecks in industrial chemistry. The lanthanides, fifteen of the seventeen rare earth elements, sit together on the periodic table and share nearly identical chemical behavior because their differentiating electrons occupy an inner 4f orbital that is shielded by outer, filled shells and largely excluded from chemical bonding.5 Commercial rare-earth separation is a case study in incremental chemistry, and one recent process-modeling study of a real Malaysian ore feedstock found that separating just four adjacent rare earth elements to commercial purity required a cascade of 379 solvent-extraction stages.6 China built its dominant position over decades by mastering exactly this kind of iterative, capital- and labor-intensive chemistry, and it now accounts for roughly 90% of global separation and refining capacity even though it mines a smaller share of global rare earth ore.7

It probably surprises no one at this point that this concentration has become a policy priority in Washington. Over the past year, the U.S. government has treated the rare earth supply chain as a national security matter. The Export-Import Bank financed the $12 billion "Project Vault" Strategic Critical Minerals Reserve,8 and the Department of Commerce finalized a $1.6 billion CHIPS Act award to back USA Rare Earth's vertically integrated "mine-to-magnet" strategy directly.9

*Against that backdrop, any technology that shortens the path to a workable, non-Chinese separation process has an obvious audience.*

A partnership that pairs a quantum computing company with a critical minerals producer is a fairly direct response to that pressure, and it is consistent with a broader wave of alternative-separation research, such as ionic liquids, continuous ion exchange, and membrane separation, that has emerged as governments look to fund optionality beyond traditional solvent extraction.10

## How Quantum Computing Is Actually Being Used

It is worth being precise about what role quantum computing plays here, because the announcement is not simply "quantum computer discovers new material." The workflow described by the companies is a hybrid one.

- Riven Systems will run its self-driving minerals-separation laboratory to conduct thousands of automated experiments, generating training data on how different candidate molecules ("extractants") selectively bind to individual rare earth elements.
- Pasqal's neutral-atom quantum processor will then be used to train and benchmark quantum machine learning models against classical machine learning models, both trained on the same experimental data, to see whether the quantum-enhanced models identify better-performing extractant candidates.

In other words, the quantum computer is not simulating a rare earth atom from first principles in this project; it is being tested as a superior pattern-recognition and optimization engine layered on top of a very large, automatically generated experimental dataset. The expected output, at least in this initial phase, is not a finished commercial chemical but a shortlist of extractant molecule candidates that outperform what is used industrially today, which would then need to be validated at bench and pilot scale before they could plausibly change plant economics. Investors should treat this as an early-stage research collaboration, not a production-ready breakthrough.

## What Is Distinctive About Pasqal's Approach

A natural question is why a French company was chosen for a project this central to U.S. industrial policy, when domestically headquartered neutral-atom quantum computing firms also exist and are actively working with U.S. national laboratories. The honest answer is that this is not a case of a missing domestic capability; several credible U.S. players work in the same hardware category.

What Pasqal specifically brings is a track record on this exact class of problem. Earlier in 2026, Pasqal, working with Los Alamos National Laboratory, reported what it characterized as a demonstration of quantum advantage in materials science on an existing rare earth magnetic material, TmMgGaO4.11 That prior result matters here, as it means Pasqal was not a generic quantum vendor being asked to try something new, but a company that had already pointed its neutral-atom hardware specifically at rare earth-adjacent materials science and published a result its team considered meaningful. Pasqal's neutral-atom architecture is also built around "analog" quantum simulation, which means directly manipulating a system of interacting atoms to mimic the physics of another quantum system, which researchers in the field have argued is particularly well-suited to chemistry and materials problems, as distinct from the gate-based digital approach more associated with error-correction-focused roadmaps. Combined with Pasqal's existing enterprise deployment history (including named commercial relationships with companies such as Aramco and Crédit Agricole) and its recent transition to a publicly listed company, it was a reasonably natural, if not the only possible, choice of quantum partner for USA Rare Earth.

## A Window Into a Broader Trajectory

We would resist reading too much into a single, early-stage partnership, but we think it is a useful marker of where both quantum computing and critical minerals strategy may be heading.

For quantum computing, this is another example, alongside work in logistics, finance and drug discovery, of the field's center of gravity gradually shifting from "can we build the hardware" toward "can this hardware help solve an economically important chemistry or optimization problem sooner than classical methods alone." Materials and chemistry simulation has long been cited as one of the more plausible near-term use cases for quantum computers, precisely because nature itself is quantum mechanical; pairing that capability with an automated, high-throughput chemistry lab (Riven's contribution) is a sensible way to generate the kind of large, clean dataset that machine learning, quantum or classical, actually needs to be useful.

For critical minerals, it is a reminder that the reshoring effort now underway in the U.S. is not just about capital and mine permits; it is also, increasingly, a technology race to find separation chemistry that does not require replicating China's decades of incremental process engineering step by step. Whether or not this specific collaboration yields a commercially deployed extractant, we expect to see more of this pattern.

*Critical minerals companies are likely to keep reaching for AI and quantum-enhanced discovery tools to compress a process that has historically taken years of trial and error.*

For WisdomTree specifically, we think this announcement is a clean illustration of why we track quantum computing (WQTM) and rare earths and strategic metals (WDIG) as related but distinct megatrends rather than a single theme. Their independent developments can still intersect, and when they do, it can create genuine collaboration value that neither theme could produce fully on its own.

## Conclusion

The Pasqal–USA Rare Earth–Riven Systems partnership is early-stage, exploratory and not yet a commercial outcome. It is, however, a concrete and well-specified example of quantum machine learning being pointed at a real, economically significant chemistry problem, by a quantum computing company with a specific and relevant prior result in the same materials family. We will be watching for the companies' benchmarking results as a signal of whether quantum-enhanced discovery can meaningfully compress the time it takes to build a competitive, Western rare earth separation capability.

1 Source for details about the collaboration: USA Rare Earth, Pasqal and Riven Systems. (2026, September 17). *USA Rare Earth, Pasqal and Riven Systems partner to advance next-generation technologies for critical mineral production* [Press release]. GlobeNewswire.

2 As of September 16, 2026, USA Rare Earth represented a 1.13% weight in the WisdomTree Efficient Rare Earth Plus Strategic Metals Fund. **Subject to change.**

3 As of September 16, 2026, Pasqal represented a 0.48% weight in the WisdomTree Quantum Computing Fund. **Subject to change.**

4 As of September 16, 2026, Riven Systems was a private company.

5 Source: Britannica. (n.d.). *Rare-earth element: Electronic structure, ionic radius*. Encyclopædia Britannica.

6 Source: **Ahmat, F., & Mohd Yunus, M. Y. (2025). Modelling the selective recovery of praseodymium, neodymium, terbium, and dysprosium from Malaysian saprolite using a multi-extraction system.** *Advanced and Sustainable Technologies (ASET), 4*(2), 1–25.

7 Source: Dasgupta, A., Kim, T.-Y., Gould, T., Buisson, E., Dhir, S., Miwa, K., Moinier, N., Nishiumi, M., Raboca, J., Scanziani, A., & Seo, S. (2026). *Rare earth elements: Pathways to secure and diversified supply chains* (Revised ed.). International Energy Agency.

8 Source: Export-Import Bank of the United States. (2026, February 6). *Week in review: Project Vault and the U.S. Strategic Critical Mineral Reserve*. EXIM.gov.

9 Source: National Institute of Standards and Technology. (2026, June 3). *The Department of Commerce's CHIPS Program finalizes definitive agreement with USA Rare Earth for up to $1.6 billion to support the company's "mine-to-magnet" strategy* [Press release]. U.S. Department of Commerce.

10 Source: Rare Earth Mining Editor. (2026, May 29). *Top 10 rare earth processing technologies in 2026.*

11 Source: Villaret, G., Albrecht, B., Béguin, L., Bourachot, L., Briosne-Frejaville, C., Claveau, D., Cornillot, A., de Hond, J., Diallo, D., Dupays, C., Zapf, V., et al. (2026). *One-to-one quantum simulation of the low-dimensional frustrated quantum magnet TmMgGaO4 with 256 qubits*. arXiv.

## Important Risks Related to this Article

There are risks associated with investing, including potential loss of principal.

**WQTM:** To the extent the Fund invests a significant portion of its assets in the securities of companies of a single country or region, it is more likely to be impacted by events or conditions affecting that country or region. The economic, political, regulatory, and other events and conditions that affect issuers and investments in the United States differ significantly from those associated with other countries and regions. U.S. financial markets have become increasingly globalized becoming more integrated with financial markets around the world and as a result, U.S. financial markets are increasingly vulnerable to the risks that may affect non-U.S. financial markets. The Fund's investments in the U.S. are subject to the risk that they, and the U.S. economy more generally, will be adversely affected by a decrease in imports or exports, changes in trade regulations, inflation, and/or an economic recession in the U.S.

The Fund invests primarily in the securities of quantum computing companies. Companies engaged in the development of quantum computing or machine learning technology may be significantly impacted by rapid technological advancements, product obsolescence, intense competition, consumer demand, and government regulation. Such companies are also heavily dependent upon patent and intellectual property rights. The Fund invests in the securities included in, or representative of, its Index regardless of their investment merit and the Fund does not attempt to outperform its Index. The composition of the Index is governed by an Index Committee and the Index may not perform as intended.

**WDIG:** The Fund is actively managed and invests in commodity metals futures contracts from an eligible exchange, and equity securities issued by global companies primarily involved in strategic metals and rare earths mining activities.

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While the Fund is actively managed, the Fund’s investment process is heavily dependent on quantitative models and the models may not perform as intended.

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