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Where Kazakhstan's Minerals Actually Go: Upstream and Midstream Destinations Diverge, but Not Uniformly

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Abstract

Analyses of Central Asia's mineral wealth typically treat a country's mineral exports as a single flow, and policy discussion of "moving up the value chain" implicitly assumes that the ore stage and the processed stage face the same buyers. This article tests that assumption at the level of named trading partners, using Kazakhstan's self-reported exports for 2024 at six-digit Harmonized System (HS) commodity level, cross-checked against the United States Geological Survey Mineral Commodity Summaries 2026 and against importer-reported mirror records where available. The result is heterogeneous rather than general. For chromium, the ore and the intermediate product point in opposite directions: chromite ore goes almost entirely to the Russian Federation (100.0% of a USD 113.7 million flow), while Kazakhstan's export record assigns ferro-chromium to China (56.7%), Japan (19.9%), Indonesia (6.3%) and the United States (5.5%). Lead shows the same divergence in reverse: lead ore goes to China (99.9%) but refined lead goes mainly to Viet Nam (71.7%). Copper shows a partial shift, and zinc shows none at all — zinc ore and unwrought zinc both go predominantly to China and the Russian Federation. Three single-stage commodities (titanium sponge, beryllium, tantalum) also have mutually different destinations. The finding is therefore not that Central Asian minerals flow in divergent directions, but that divergence is commodity-specific and cannot be read off an aggregate commodity indicator. Two measurement limits bound the conclusion: bilateral records disagree by 63% for China on one commodity, ferro-chromium (HS 720241), in a direction this study cannot explain, and for one commodity two of the three parallel quantity fields the response carries are unpopulated on the aggregate row — qty returns zero with unit code -1, and netWgt is null — so only the third, altQty, can be reconciled. Neither is treated here as evidence of rerouting or of misreporting.

Keywords: Central Asia; Kazakhstan; critical minerals; chromite; ferrochromium; trade statistics; value chains; export destinations

1. Introduction

Central Asia's mineral endowment has re-entered discussions of global supply security. One Earth's review argued that the region had been "forgotten in contemporary global critical materials analyses" and that its significance lies chiefly in the *diversity* of its mineral base rather than in dominance of any single material (Vakulchuk & Øverland, 2021). Regional scholarship has extended this into policy prescription, proposing deeper domestic processing, export diversification and environmental, social and governance

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standards as the route from a resource-dependent export model to something more durable (Panzabekova et al., 2025). A parallel geological and competitiveness strand addresses the same region (Issatayeva et al., 2024); only its abstract and front matter were available to this study, so no finding of it is relied on here. A third literature asks whether governments can force that transition: an OECD study of four mineral-rich African countries — including chromite in Zimbabwe — found that export restrictions did not in fact improve the revealed comparative advantage of processed products (Fliess et al., 2017).

Both strands share a simplifying step. The resource-base literature describes what is in the ground; the policy literature asks whether restrictions shift activity downstream. Neither asks a prior descriptive question: **in the trade that actually occurs, do the ore stage and the processed stage of the same mineral reach the same destinations?** If they do, ”moving up the value chain” is largely a question of domestic capability. If they do not, then the commercial counterpart of an upgrading strategy is different depending on which buyer the upgraded product would serve — and a strategy formulated against an aggregate commodity total will not see the difference.

This article examines that question for Kazakhstan, the region’s largest mineral economy, at the level of named partner countries and individual processing stages. It makes no causal claim about why destinations differ. Its contribution is descriptive and mechanical: it shows how much structure disappears when ores, metals and precious stones are treated as one indicator, and it documents how unevenly that structure behaves across commodities.

The article proceeds as follows. Section 2 sets out the data, the unit-inference problem and the verification posture. Section 3 reports the stage-by-destination results and the counterexamples. Section 4 discusses what the pattern does and does not license, and Section 5 concludes.

2. Data and method

2.1. Sources

Three source families are used.

Trade records. Kazakhstan’s self-reported exports for 2024 at six-digit HS level were taken from the United Nations Comtrade public preview interface (United Nations Statistics Division, 2024). Eleven commodity codes were retrieved, covering both stages of four minerals and the available stage of three others (Table 1). The interface returns annual aggregates for the requested year; no key is required. Importer-reported mirror records were retrieved for the same commodity and partner pairs where the reporting country published them.

Geological and production baseline. Commodity chapters of the United States Geological Survey *Mineral Commodity Summaries 2026* were used for production, capacity and United States import-source shares. The earlier project evidence ledger records 5 February 2026 as the creation date of the chapters used and records later-created chapters as excluded. Those chapter PDFs are absent from the current project copy, so their creation dates and the transcribed source figures were not independently verified in this review.

Peer-reviewed context. Reference works were identified by keyword search and each was verified against a DOI registry before use; sources whose full text or abstract could not be read are not used to support specific claims.

Evidence cutoff and data vintage. The study’s target evidence cutoff is 20 February 2026. The retained tables describe 2024 trade. The earlier project record reports Comtrade retrieval in September 2026, but the original API responses and acquisition logs are absent from this project copy, so the original acquisition date is not independently established. On 26 September 2026, the present review examined the retained tables and records; it did not re-download the original trade extracts. The versions retained and checked in this round do not independently establish that identical values were publicly available by

the target cutoff. The original Comtrade responses and USGS chapter PDFs remain unavailable in this project copy.

2.2. *Units, documentation and consistency checks*

The Comtrade quantity-unit reference defines code 8 as kilograms. All 91 rows in the eleven extracts carry altQtyUnitCode=8; every populated qty field also carries code 8. Both isNetWgtEstimated and isQtyEstimated are false throughout, so the unit values use reported rather than imputed quantities.

Refined copper is the only commodity whose World row reports quantity code −1 and zero quantity while partner rows report quantities. Four populated partner qty rows sum to 422,583,473 kg; the parallel altQty field adds Russia's 7 kg and reconciles all five partners to 422,583,480 kg. The value field reconciles independently.

The response payload has no currency field. UNSD processing documentation states that national-currency values are converted to US dollars before dissemination (United Nations Statistics Division, 2020). Export rows carry fobvalue=primaryValue, establishing an FOB valuation basis. Magnitude comparisons are consistency checks, not the basis for assigning USD and not observations of market prices.

Two unit values have comparable USGS benchmarks. Titanium sponge is USD 12.036/kg against USD 13.30/kg, a 9.5% difference; refined lead is USD 1.927/kg against USD 2.399/kg, a 19.7% difference (U.S. Geological Survey, 2026). The remaining unit values are reported as customs unit values for the observed grade, contract and destination mix.

2.3. *Aggregation and partner mapping*

For all eleven commodities, named-partner values sum to 100.00% of the corresponding World record. Completeness refers to the returned partner decomposition and includes residual reporting groups such as "Other Asia, nes"; it does not imply that every record is a country. Partner names are resolved from the publisher's code table.

Destination shares use the complete returned partner set. Refined copper quantities use the populated partner rows described in Section 2.2, and all other commodities reconcile directly on value and quantity. The analysis therefore reports final reconciled totals rather than selected-partner subtotals or intermediate working counts.

2.4. *What the evidence cannot show*

Three limitations are structural and are carried into every interpretation.

Single-reporter dependence. The destination tables rest on Kazakhstan's own declarations. Importer mirror records exist for Japan and China and are reported below; for the Russian Federation and the United States the relevant bilateral records are unavailable at this interface. Absence of a record is treated throughout as unavailability, never as zero trade. This distinction is not cosmetic: at this interface United States import records are missing for ferro-chromium from *all* partners, including China, so the gap is a coverage artefact of the endpoint rather than a fact about Kazakhstan. The same reporter's own export record is **not** an independent check, because it comes from the same reporter as the headline figure. What it shows is that the mirror endpoint's omission is a coverage gap in that endpoint rather than a fact about the trade.

Bilateral disagreement. For Japan, Kazakhstan's declared exports to Japan (USD 380.7 million) against Japan's declared imports from Kazakhstan (USD 441.4 million) differ by about 16%. Ferro-chromium (HS 720241) is the only commodity for which both sides return usable bilateral records; for chromite ore the partner-level mirror response is empty for every partner, so no comparison is possible there. For China the two sides differ by 63.3% in value and 29.7% in weight on that commodity, and the direction is unusual: China reports both more value and more weight than Kazakhstan reports exporting,

whereas for Japan the importer reports more value but *less* weight. The cause is not established here, and the article does not speculate about it. Valuation basis (free-on-board versus cost-insurance-freight) is insufficient, since freight margins of 5–10% cannot account for 63%, and a classification substitution into the adjacent ferro-chromium subheading does not fit either, because China's declared imports of that subheading from Kazakhstan amount to USD 19. This discrepancy is reported as an unresolved measurement limit, not as evidence of any behaviour.

One aggregate row does not populate every quantity field. For refined copper the World row returns quantity-unit code -1, "Not available or not specified or no quantity", with qty at zero and netWgt null, although its partner rows carry quantities. Checked across all eleven commodities, the value field aggregates exactly in every case; the qty field aggregates in ten and fails only here; and the parallel altQty field aggregates for all eleven, refined copper included. The two statements therefore hold at once, and the distinction is which field is meant. The unit value for refined copper is therefore computed from the partner rows that carry a quantity, and the resulting difference is disclosed in Table 2 rather than smoothed over. No other commodity is affected, so this is a single isolated reporting artefact and not a systematic property of the series.

Small-base commodities require a further caution. Unwrought beryllium exports total 25,005 kg and unwrought tantalum 109,278 kg for 2024. At those magnitudes a single contract can move a share substantially, and percentage shares should not be read as stable structural features.

3. Results

3.1. Chromium: opposite directions

Chromium is the clearest case, and it is also where the aggregate indicator is most misleading.

Kazakhstan's chromite ore exports in 2024 totalled USD 113.7 million. Of this, USD 113.7 million — 100.0% — went to the Russian Federation. This is the article's starkest figure and it carries the least corroboration: the Russian Federation's own import record for this commodity is not available at the interface, so the 100.0% figure rests on a single reporter, and no mirror record either confirms or contradicts it. Australia, a named partner rather than a residual grouping, accounts for USD 1,083. No ore went to China, Japan, Korea or India. Over the same year Kazakhstan's ferro-chromium exports (HS 720241, carbon content above 4%) totalled USD 1.92 billion, distributed across 22 partner records — one of which, at 0.10%, is the residual grouping "Other Asia, nes" rather than a country: China 56.7% (USD 1.09 billion), Japan 19.9% (USD 380.7 million), Indonesia 6.3%, the United States 5.5% (USD 104.6 million), Germany 3.2% and the Republic of Korea 2.0%.

The ore and the alloy therefore do not share a destination structure at all. They share no destination of consequence: the ore goes to one neighbour, the alloy goes to East and Southeast Asia, to Europe and to North America.

Section 2's warning about mirror coverage is directly relevant here. At the preview interface, United States import records for ferro-chromium from Kazakhstan are empty; on that basis alone one might conclude that the United States is not a destination. The same reporter's own export record shows otherwise. This is a concrete instance of the general rule that an empty record is not a zero.

The United States Geological Survey baseline places the two stages differently in global supply, and the direction is not the one a first guess would suggest. The 2026 summary lists Kazakhstan as the source of 24% of United States ferro-chromium imports, 25% of chromium chemical imports and 11% of total chromium imports (U.S. Geological Survey, 2026). It also records Kazakhstan as the world's **third-largest** chromite ore producer: 6,100 thousand tonnes in 2024 and 7,000 thousand tonnes estimated for 2025, against ore reserves of 230,000 thousand tonnes, behind only South Africa and Turkey. The same chapter states that world chromium resources are about 95% in Kazakhstan and southern Africa. Kazakhstan is

therefore not a marginal upstream supplier that happens to process: it is a major ore producer. Its exported ore nonetheless goes almost entirely to a single neighbour — although exports are only about 5% of what it produces, so most of the ore does not leave at all — while its alloy reaches East and Southeast Asia, Europe and North America. That configuration — a large upstream position combined with a single-buyer ore flow — is precisely what makes the ore stage's destination and the alloy stage's destination separable questions.

3.2. Lead: the same divergence, in reverse

Lead repeats the pattern with the stages swapped in importance. Kazakhstan's lead ore and concentrate exports in 2024 were USD 51.72 million, of which China took 99.9% (USD 51,681,800); Türkiye and the United Kingdom account for a few thousand dollars each. Refined lead, by contrast, totalled USD 197.2 million and went mainly to Viet Nam — 71.7%, or USD 141.4 million — with China at 16.6% and Türkiye at 10.9%.

So for lead the raw material is effectively a single-buyer flow to China, while the processed metal is predominantly a Viet Nam flow. An analysis that tracked "lead" as one commodity would average these into a single China-dominated picture and would miss that roughly 72% of the higher-value processed flow has a different destination. The region is also a lead producer, with Tajikistan estimated at 39 thousand tonnes (U.S. Geological Survey, 2026).

3.3. Copper: a partial shift

Copper behaves differently in degree. Copper ore and concentrate exports in 2024 were USD 3.16 billion: China 91.0% (USD 2.88 billion), the Russian Federation 6.9%, Uzbekistan 2.1%. Refined copper cathodes were USD 3.66 billion: China 67.8% (USD 2.48 billion) and Türkiye 31.3% (USD 1.15 billion), with Singapore at 0.9% (USD 31.7 million) and only nominal amounts elsewhere — Belarus at USD 410,022 and the Russian Federation at USD 18,376. Five partner records account for the whole total, so nothing is hidden in an unlisted remainder.

The processed stage is thus still China-led, but a second destination of real size appears — Türkiye, at nearly a third of the refined flow and absent from the ore flow. This is a shift of composition rather than a reversal of direction, and it is a third distinct shape rather than a variant of the chromium case.

Refined copper's World row reports no quantity, but four of its five partner rows do, so its unit value is computable after all (USD 8.667/kg, Table 2), and the comparison above holds in mass terms as well as in value terms.

3.4. Zinc: the counterexample

Zinc does not show the pattern, and saying so is part of the result.

Zinc ore and concentrate exports in 2024 were USD 336.1 million, going to China (63.7%), the Russian Federation (23.8%) and Uzbekistan (12.4%). Unwrought zinc was USD 586.6 million, going to China (55.8%), the Russian Federation (27.9%), Viet Nam (10.3%) and Türkiye (5.6%).

The two stages face substantially the same partners in substantially the same order. The processed stage is worth about 1.7 times the ore stage and shows somewhat wider diversification, but there is no divergence of the chromium or lead kind. Kazakhstan is an established zinc producer, mining an estimated 360 thousand tonnes in 2025 with reserves of 7.4 million tonnes (U.S. Geological Survey, 2026), so this is not a case of a marginal or unrepresentative flow.

Zinc is therefore an explicit counterexample within the same country and the same year, and it is what prevents the finding from being stated as a regional regularity.

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3.5. Single-stage commodities: destinations that agree with nobody

Three commodities are available at only one stage in the data, and their destinations do not resemble one another.

Titanium sponge exports were USD 215.2 million, going to France (40.8%), Belgium (27.0%), the Republic of Korea (16.7%), the United States (4.4%), Estonia (3.1%) and India (2.8%). That Kazakhstan produces sponge at all is independently recorded: 19,000 tonnes estimated for 2024 against a capacity of 26,000 tonnes (U.S. Geological Survey, 2026). The United States sponge import mix has also moved: the 2021–2024 average source shares were Japan 77%, Saudi Arabia 13% and Kazakhstan 8%, while for 2025 the reported shares are Japan 73%, Kazakhstan 13% and Saudi Arabia 13% (U.S. Geological Survey, 2026).

Unwrought beryllium exports were small in volume — 25,005 kg — and highly concentrated: China 93.1% and the United States 6.9%. Unwrought tantalum exports were 109,278 kg and went to the United States (44.9%), Japan (20.4%), the Russian Federation (20.4%), the Republic of Korea (9.5%) and China (3.2%).

Taken together, the three midstream commodities have three different leading destinations — France, China and the United States. There is no single ”processed minerals destination” for this economy.

3.6. Summary of shapes

Table 1 summarises the stage-and-destination structure. Four distinct shapes appear: strong divergence (chromium), divergence with the stages reversed in importance (lead), partial compositional shift (copper), and no divergence (zinc). Figure 1 shows the same four cases as paired bars, so that the divergence — or its absence — can be seen without comparing table rows.

4. Discussion

4.1. What the result is

The result is a statement about the resolution at which mineral trade is described. When ores, metals and precious stones are combined into a single indicator and destinations are aggregated into continental blocs — the approach taken in the closest regional forecasting work (Panzabekova et al., 2025) — the four shapes in Table 1 are invisible by construction. Chromium and zinc produce the same kind of aggregate line; lead and copper something else again.

The practical consequence concerns how an upgrading agenda is specified. ”Move up the value chain” is a statement about capability. But the commercial content of an upgraded product depends on who buys it, and Section 3 shows that the buyer of the processed stage is not the buyer of the ore stage in two of the four minerals examined, is partly a new buyer in a third, and is the same buyer in the fourth. If a strategy is justified by an aggregate export line, that variation is not visible in the evidence used to justify it. This does not make such strategies wrong; it means their destination implications have to be argued separately for each mineral rather than inherited from a total.

The findings also qualify, without contradicting, the export-restriction literature. The OECD study found that restrictions did not improve downstream comparative advantage for four African minerals including chromite (Fliess et al., 2017). This article does not test policy effects. What it adds is the starting configuration against which such effects would be measured: for chromium in Kazakhstan, the upstream and midstream flows already have disjoint destinations, so a policy that increases domestic smelting would be redirecting material whose ore-stage and alloy-stage customers are not substitutes.

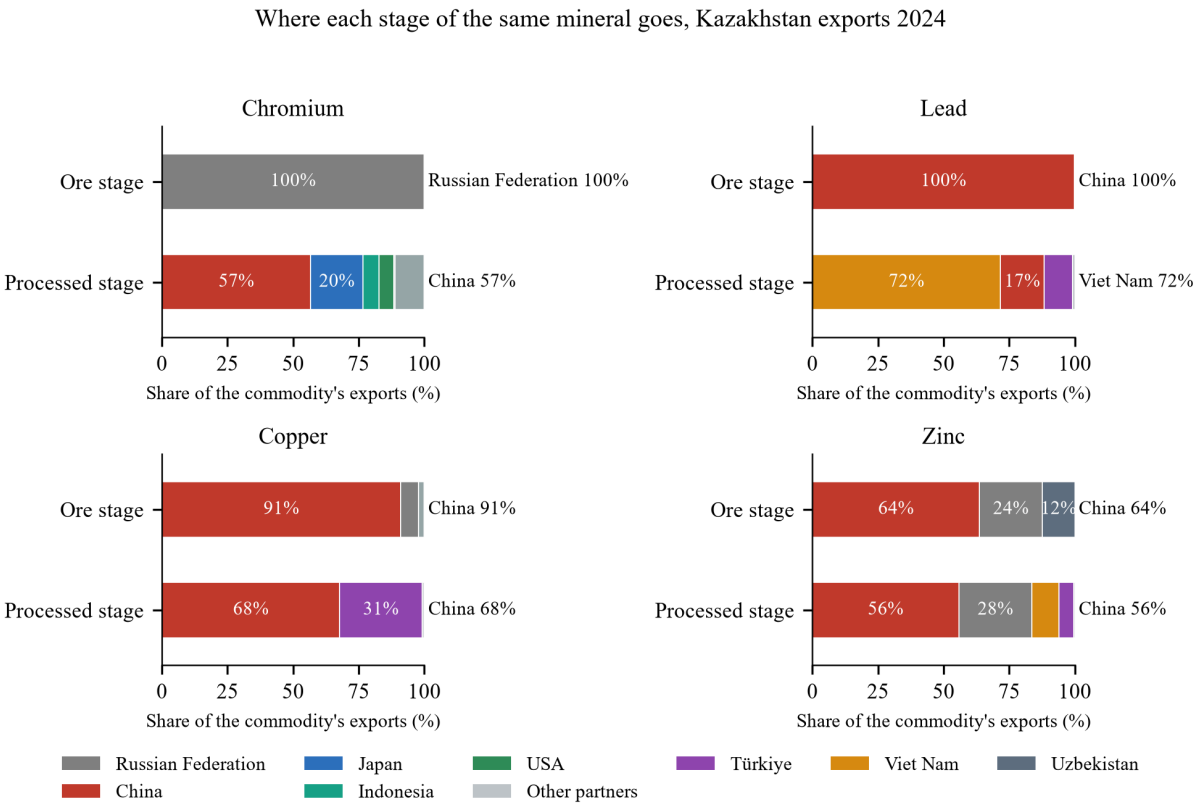


Figure 1. Where each stage of the same mineral goes. Kazakhstan's self-reported exports, 2024; each bar is one commodity and its segments sum to 100.0%. For each mineral the upper bar is the ore stage and the lower bar the processed stage. Chromium and lead show the two stages facing different destinations; copper shows a partial shift, with Türkiye entering only at the refined stage; zinc shows substantially the same destinations at both stages. The leading destination is named beside each bar so that the figure remains readable without colour. Segments are plotted from the same table as Table 1.

4.2. What the result is not

The article does not establish why destinations differ. It contains no measure of processing capacity, no freight or logistics data, no contract or price data beyond unit values, and no information about ownership or offtake arrangements. A divergence between an ore flow and an alloy flow is compatible with several explanations, including transport economics, the location of smelting capacity, long-standing industrial ties, and corporate structure. Nothing here distinguishes among them, and no geopolitical interpretation is offered.

The article also does not establish a regional pattern. Zinc is the counterexample within the same reporter and the same year, and the three single-stage commodities have three different leading destinations. Any generalisation beyond the commodities examined would be unsupported.

Unit values are reported only as an internal consistency check on the value and quantity fields. Differences in unit value between destinations are not interpreted as price discrimination, because no adjustment for grade, chromium or carbon content, contract form or timing has been made.

Finally, the 63% bilateral disagreement with China is an open problem. It is large enough to affect any statement about the magnitude of the China flow, though not large enough to alter the direction of the finding, since China is a major destination under either side's record. Until the discrepancy is explained, magnitudes involving China should be treated as a range rather than a point.

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4.3. Relation to the wider literature

The One Earth review's central claim was that Central Asia is under-represented in critical-materials analysis (Vakulchuk & Øverland, 2021). This article supports that claim with a specific gap: the region's mineral trade is routinely analysed at a resolution at which its most distinctive structural features — which mineral's stages diverge, and toward whom — cannot appear. Multi-regional input-output work has extended critical-mineral accounting across all supply-chain stages for European consumption (Berthet et al., 2024); the present contribution is complementary, working from bilateral trade records rather than from consumption-based footprints, and at the cost of the geographic breadth that an input-output approach provides.

5. Conclusion

For seven minerals and eleven commodity codes, Kazakhstan's 2024 export records show that the destination structure of a mineral's ore stage and its processed stage are not the same thing. For chromium they are opposite; for lead they are opposite and the processed flow is the more valuable; for copper they partially overlap with a new destination entering at the refined stage; for zinc they are the same. The partner decompositions reconcile to the reported totals at 100.00%, so the structure is not an artefact of the partner list.

The evidence has three material limits. The destination tables rest on one country's declarations. Mirror records are available for two partners, agree loosely with one and disagree substantially with the other in a manner this article cannot explain. One commodity's aggregate row reports no quantity, although four of its five partner rows do. Two commodities rest on bases small enough that individual contracts could move their shares.

For a region whose mineral wealth is discussed as a single strategic asset, the trade geography of that wealth is commodity-specific, and the resolution at which it is usually summarised cannot show it.

6. Declarations

Evidence cutoff. Target cutoff: 20 February 2026. Data-vintage and acquisition-date status are specified in Section 2.1.

Issue metadata. Issue date, volume, article number and DOI are withheld pending confirmation by the editor-in-chief.

Data availability. The reduced partner-level and unit-value tables (analysis/partners-full.csv, analysis/unit-values.csv) and the analysis scripts that built and checked them are held with the project record; the retained rows support recomputation of partner shares, trade values and the mirror discrepancies covered by those tables. For eight of the eleven commodity rows in Table 2, only the arithmetic from the printed value and weight has been independently checked; the corresponding weights have no second retained data source. USGS production, reserve and import-share figures have not been independently checked against the missing source chapters. The original United Nations Comtrade API JSON responses and the source PDF chapters of the USGS *Mineral Commodity Summaries 2026* are not present in this project copy and are not available for independent re-derivation from primary sources. The quantity unit is taken from the publisher's quantity-unit reference; USD follows UNSD processing documentation cited in Section 2.2.

Competing interests. None declared.

7. Tables

Table 1. Stage and destination structure, Kazakhstan self-reported exports, 2024.

Mineral	Upstream commodity	Leading destinations	Midstream commodity	Leading destinations	Shape
Chromium	Chromite ore (HS 261000)	Russia 100.0%	Ferro-chromium >4% C (HS 720241)	China 56.7%, Japan 19.9%, Indonesia 6.3%, USA 5.5%	Strong divergence
Lead	Lead ore (HS 260700)	China 99.9%	Refined lead (HS 780110)	Viet Nam 71.7%, China 16.6%, Türkiye 10.9%	Divergence, stages reversed
Copper	Copper ore (HS 260300)	China 91.0%, Russia 6.9%	Refined copper (HS 740311)	China 67.8%, Türkiye 31.3%	Partial shift
Zinc	Zinc ore (HS 260800)	China 63.7%, Russia 23.8%	Unwrought zinc (HS 790111)	China 55.8%, Russia 27.9%	No divergence
Titanium	—	—	Titanium sponge (HS 810820)	France 40.8%, Belgium 27.0%, Korea 16.7%	Single stage
Beryllium	—	—	Beryllium unwrought (HS 811212)	China 93.1%	Single stage, small base
Tantalum	—	—	Tantalum unwrought (HS 810320)	USA 44.9%, Japan 20.4%, Russia 20.4%	Single stage, small base

Note. shares are of the World record for the same commodity and year; the sum of the returned partner rows equals the World record at 100.00% for every row, but those rows include residual groupings and are not all countries (Section 2.2). HS 720241 covers ferro-chromium with carbon content above 4%.

Table 2. Unit-value consistency check, Kazakhstan exports, 2024.

Commodity	Value (USD)	Net weight (kg)	Unit value (USD/kg)	Reference price, and its source
Chromite ore (HS 261000)	113,724,532	294,191,027	0.387	scale only; no source used
Zinc ore (HS 260800)	336,139,612	431,051,463	0.780	scale only; no source used
Lead ore (HS 260700)	51,720,663	45,747,428	1.131	scale only; no source used
Ferro-chromium (HS 720241)	1,917,069,432	1,466,015,843	1.308	scale only; no source used
Copper ore (HS 260300)	3,159,589,922	1,852,076,778	1.706	scale only; no source used
Refined lead (HS 780110)	197,232,491	102,367,968	1.927	**USD 2.399/kg** (108.8 cents/lb, 2024 North American average, USGS 2026)
Unwrought zinc (HS 790111)	586,614,743	225,316,565	2.604	scale only; no source used
Refined copper (HS 740311)	3,662,618,356 †	422,583,473	8.667	scale only; no source used
Titanium sponge (HS 810820)	215,191,863	17,878,390	12.036	**USD 13.30/kg** (2024 annual average, USGS 2026)
Tantalum unwrought (HS 810320)	33,819,419	109,278	309.481	scale only; no source used
Beryllium unwrought (HS 811212)	24,424,318	25,004.8	976.785	scale only; no source used

Note. the Value column is the **World** record for the commodity and year; the Net weight column (netWgt) is the sum of the partner rows that carry a quantity, printed as the publisher's response returned them rather than re-derived, so that each unit value follows from the printed inputs. Rounding is present in some cells and is not asserted away. The kilogram reading rests on the publisher's quantity-unit reference, whose code 8 is defined as kilograms. The USD reading follows UNSD processing documentation; scale and ordering are consistency checks, as Section 2.2 states; two rows carry a published reference price and the rest are offered as scale only. † Refined copper is the one commodity whose qty field fails to aggregate: the World row returns code -1 with a zero quantity, and so does the Russian record, although the latter does carry 7 kilograms in the parallel altQty field. The value figure of 3,662,618,356 is therefore the total of the four partner rows whose qty field is populated, against a World value of 3,662,636,732; the difference of USD 18,376 is the Russian Federation record. Read in altQty instead, the same World row returns 422,583,480 kilograms, exactly the sum of all five partner rows — the 422,583,473 kilograms above plus Russia's 7. **Quantity therefore aggregates for all eleven commodities**; what fails is one field's population for one commodity, not the data. Every other commodity's World row equals the sum of its partners in all three fields.

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