Online Resource 1 — Evidence codebook and case coding

Critical-Mineral Upgrading Across Project Stages: A Comparative Framework for Industrial Policy

Mineral Economics — double-anonymous review material

This online resource documents the evidence protocol for the manuscript. Data freeze: **4 October 2026**. The categories below are **documentary classifications**, not statistically validated scores, investor ratings or claims of consensus among coders.

A1. Units, gates and rules fixed for this reconstruction

Unit: named project or production system, **not** the country's entire mineral economy. **Product:** state its chemical/physical form and whether the number is a forecast, nameplate, actual production or sales. A lithium *resource* is not a reserve; the USGS Bolivia figures are **tonnes of elemental lithium**, whereas YLB plant output is **tonnes of Li_2CO_3 product**. MMG reports **tonnes of copper metal in concentrate**, not tonnes of concentrate mass or refined cathode. Never directly compare these tonnages across minerals.

Evidence hierarchy: statute/court/ministry for legal act and status; published corporate operating report for company-specific actual output and company expectations; independent peer-reviewed evidence for general mechanisms; civil-society analysis for specific objections to test, not a final permit determination; national WGI for broad context only. A draft EIA is not an approved EIA. A restored spatial plan is not an exploitation permit. A signed proposed DLE contract is not an installed process or proven recovery. A live registered social conflict with no event in a month is not a blockade in that month.

Observed production class: P0 = no verified named-system commercial product yet; P1 = verified product output, but sustained target-level or commercially viable scale not established by the documents; P2 = established operating production at scale. This class does **not** say a project is permitted in all respects, is profitable, or has social consent. **Domestic transformation:** D0 = no verified domestic transformed product from the named project/system beyond initial extraction or concentration; D1 = verified chemical or metallurgical transformation within country; D? = insufficient disclosure. Domestic refining after a copper concentrator is a **separate** D1 test, not a synonym for producing concentrate. **Governance status:** record the exact act and date rather than a numeric WGI-to-permit score.

A single researcher applied the evidence protocol. There was **no second independent coder**, preregistration or intercoder-agreement statistic. Accordingly, ordinal 1–5 scoring and unverified event counts are not used. The numerical values reported in the figures derive from the World Bank WGI release, YLB reports and MMG production disclosures cited in the manuscript.

A2. Dated evidence and coding decisions

Case/domain	Source-backed observation (date, product and unit)	Coding decision	Evidence that would revise the classification
Jadar—economic	Rio Tinto's July 2021 conditional US$2.4bn commitment and proposed 58,000 t/y lithium carbonate after ramp-up; company release	Prospect, **not observed output** (P0); historic sponsor forecast	Updated independently assessed cost, permits, final investment decision and first commercial product
Jadar—strategic	Commission's 2025 decision annex designates a strategic **extraction** project	Strategic recognition verified; local battery manufacturing **not** thereby verified	Actual domestic supply contracts/plant and verified value added

Case/domain	Source-backed observation (date, product and unit)	Coding decision	Evidence that would revise the classification
Jadar—governance	Court ruling communiqué (11 July 2024), restored 2020 spatial plan (effective 17 July 2024), ministry EIA *scoping* notice (21 November 2024)	Spatial and assessment steps verified; final EIA approval/exploitation/operation **not established**	Comprehensive permit register and approved EIA for full project
Jadar—sustainability	Surveyed perceived impacts; RERI critique of segmented assessment; sponsor says project entering care and maintenance (accessed 4 October 2026)	Material contested issues; no numeric consent or observed pollution score assigned	Independent comprehensive EIA, consultation records and longitudinal site monitoring
Uyuni—economic	YLB 2024 annual report reports 2,064.46 t Li_2CO_3 in 2024; 2025 report, §3.1.3, 2,462 t produced against 3,500 t internal plan; existing plant rated 15,000 t/y	P1, **real carbonate output, but no demonstrated sustained design-level operation**; transformation to carbonate is observed (D1 at smaller scale)	Audited cost, quality, recovery, uptime and viability at specified lithium prices
Uyuni—strategic	USGS 2026 lithium: 23 Mt *elemental lithium resources for Bolivia*; YLB May 2026: 21 Mt *Uyuni lithium resources*	Geological significance verified; neither number is a reserve or product output	Salar-specific competent-person reserve/economic study and comparable unit conventions
Uyuni—governance	Uranium One approval bill (14,000 t/y proposed Li_2CO_3) and CBC approval bill (35,000 t/y proposed); YLB 2026 initial plan conditional on judicial/parliamentary steps; chamber archive	Signed project plans, not commissioned DLE plants; do not assume contract ownership split	Enacted approvals, enforceable technical contracts, commissioned output, public procurement and benefit terms
Uyuni—sustainability	Process review and Uyuni wastewater study show monitoring questions; constitution requires consultation and benefit participation	Water/waste/participation gate open; no unsupported water-use benefit or consent rating	Public basin-specific freshwater/brine mass balance, impact assessment and affected-party monitoring
Las Bambas—economic	MMG 2025 annual results, p. 13, **410,834 t contained copper in concentrate in 2025**	P2 as operating concentrator; **no project-level domestic refined-copper output evidenced** (refining D0 for this project)	Separate smelter/refinery documentation, feed supply, finance, energy, emissions and economics
Las Bambas—strategic	MMG operations confirms road-to-rail export of concentrate via Matarani	Strong global copper-supply role does not prove downstream Peruvian value capture	Peru-based refining investment, output and local suppliers attributable to project
Las Bambas—governance	MMG 2022 annual results report **52 d** full-site cessation and **173 d** concentrate-transport disruption as separate events; MEF canon	Logistics and fiscal channels need evidence; days must not be added; no mine-specific canon amount inferred	Route-level agreements, transaction-level transfer attribution and public investment execution

Case/domain	Source-backed observation (date, product and unit)	Coding decision	Evidence that would revise the classification
	method = **50% of income tax from mining right-holders**, distributed territorially		
Las Bambas—sustainability	Defensoría March 2026: named active conflict cases but none with events in month; MMG 19 August incident and 21 August restart	Distinguish persistent registered grievances from actual blockade; separate fatal safety incident from social-conflict episodes	Future quarterly production/transport series and independently verified corridor/community conditions

A3. Non-compensatory RUDM status matrix

The status in each domain applies to the **next stated transition**, not to a country's overall development or the project's permanent value. **Established** means the evidence required for that transition is documented. **Partial** means that some relevant evidence exists but a material condition remains unresolved. **Not demonstrated** means that the evidence required for the next decision is incomplete or unavailable in the accessible record. A project progresses only when all stage-relevant conditions are established; one unresolved condition, or a jointly unresolved bundle, identifies the binding gate.

System and transition	Product stage	Economic feasibility	Strategic importance	Governance complexity	Sustainability and social licence	Binding gate
Jadar: P0 → P1	P0/D0	Not demonstrated	Established	Not demonstrated	Not demonstrated	Joint authorisation–legitimacy–finance gate
Uyuni: P1 → sustained scale	P1/D1 at limited scale	Partial	Established	Partial	Not demonstrated	Technical-commercial scale-up gate coupled to contract and environmental-accountability conditions
Las Bambas: P2/D0 → D1 and broader linkages	P2/D0	Established for concentration; not demonstrated for refining	Established	Partial	Partial	Benefit-and-logistics gate, then a separate refining appraisal

A4. Sensitivity and limitations register

Observation date. Jadar's 2024 planning revival and 2025 strategic designation do not overturn P0 at the October 2026 cut-off; company care-and-maintenance is the latest original-source status located. Uyuni was pilot-dominant in 2023, with actual industrial carbonate output by 2025, so its class can change when repeatable scale is evidenced. Las Bambas was fully shut for 52 days in 2022 but produced 410,834 tonnes contained copper in 2025, so the 2022 event cannot be treated as a permanent operational state. The August 2026 safety interruption adds a **different mechanism**, not fresh evidence of a 2026 community blockade.

Alternative WGI proxy. The 2025 WGI absolute scores (not percentiles) are national context. Replacing government effectiveness with regulatory quality or excluding WGI leaves P0/P1/P2 and concentrate-versus-refining classifications unchanged; the legal and product-stage decisions never depend on WGI thresholds. No arbitrary 1–5 weights are required or claimed. WGI 90% confidence intervals must be displayed with cross-country comparisons.

The official source advisory cautions against treating perception aggregates as definitive rankings or specific investment decisions.

Unresolved evidence. There is no uniformly coded, reproducible mining-protest event series; no project-by-project CAPEX/GDP return comparison; no Las Bambas-specific smelter feasibility model; no completed Uyuni DLE cost/recovery appraisal; and no direct local survey establishing a numeric social-licence index across all cases. A clear second-coder protocol and adjudication log are still required for a stronger empirical submission. These are **research limits**, not values to impute.

A5. Supplementary governance context

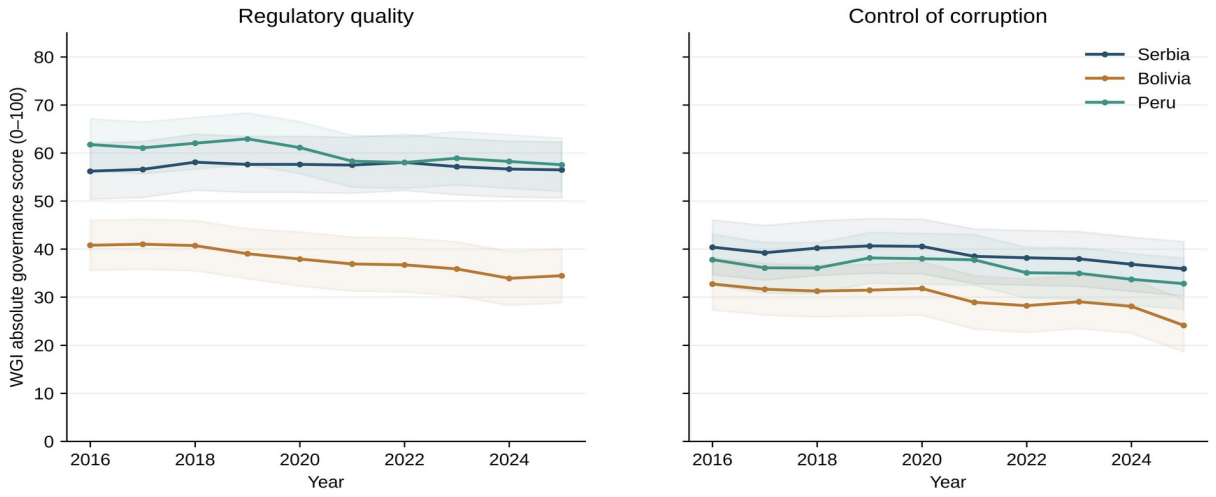


Fig. S1 *Regulatory-quality and control-of-corruption scores for Serbia, Bolivia and Peru, 2016–2025. Shading indicates the World Bank's published 90% confidence intervals. These national indicators provide context only and are not project-level measures of permitting, benefit sharing or social consent. Source: World Bank (2026a); authors' calculations*

Online Resource 1 caption. Evidence codebook and case coding for *Critical-Mineral Upgrading Across Project Stages: A Comparative Framework for Industrial Policy*, including the RUDM evidence protocol, coding register, sensitivity notes and Fig. S1. This file contains no author-identifying information for double-anonymous review.