Revisión de los procesos metalúrgicos en los Reportes Técnicos NI 43-101

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06-Abril-2022

Agenda

1. Introducción NI 43-101
2. Capítulo 13: Procesamiento de mineral y pruebas metalúrgicas
3. Manejo y mitigación del Riesgo en Ingeniería de Procesos
4. Consultas

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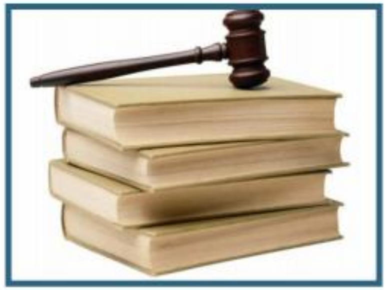
NI 43-101

¿Cual es el objetivo de NI 43-101?

- El objetivo de NI 43-101 es asegurar que la publicación de información al mercado se base en fuentes confiables, reflejando opiniones profesionales, basada en las mejores prácticas de la industria y usando términos estandarizados.

Qualified Person



Standards & Best Practices

Technical Report

Fuente: Ontario Securities Commission

Flujo de información técnica dentro del NI 43-101

Fuente: Ontario Securities Commission

Rol de la persona competente en reportes técnicos NI 43-101

Inicialmente: Evaluar la respuesta del proceso considerado ante la variabilidad del depósito para soportar la definición apropiada de ley de corte.

Con mayor información disponible se debe generar la siguiente información:

- Logueo geometalúrgico del depósito
- Selección de muestras y pruebas metalúrgicas
- Interpretación y modelamiento de resultados pruebas metalúrgicas
- Definición del proceso
- Diseño de Ingeniería
- Estimación Costos de Capital
- Estimación Costos Operativos

Fuente: CIM Guideline Mineral Processing

Ausenco

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Capítulo 13: Procesamiento de mineral y pruebas metalúrgicas

Sustento Metalúrgico - Capítulo 13

Foco Principal - Capítulo 13

El capítulo 13 contiene lo referente a el tipo de proceso utilizado para la obtención del elemento de interés y las pruebas metalúrgicas que respaldan tanto el procesos como su recuperación.

- Se deben enunciar claramente los supuestos utilizados para la estimación de las recuperaciones.
- Representatividad de las muestras utilizadas
- Enunciar cualquier factor de procesamiento o elemento nocivo que pueda tener un efecto significativo en la extracción económica potencial.
- Tabla resumen de todas las pruebas metalúrgica llevadas a cabo
  - Conminución
  - Recuperación
  - Otras (Permeabilidad, tasas de filtración, etc)

Tabla Contenido – Capitulo 13

1. Introducción
2. Pruebas Metalúrgicas
3. Estimación de Recuperaciones
4. Variabilidad Metalúrgica
5. Elementos Nocivos para el proceso
6. Comentarios del capitulo (QP)

- Laboratorios utilizados
- Procesos evaluados en el desarrollo de las distintas fases de la ingeniería
- Tabla resumen del programa metalúrgico

Year	Laboratory	Testwork Performed
1962 to 1963	Lakefield Research	Mineralogy, flotation and grindability tests
1963 to 1964	Canadian Department of Mines and Technical Surveys	Mineralogy
1964	Britton Engineers, Vancouver, BC,	Open cycle rougher flotation recovery and grindability tests, cleaning tests, specific gravity determinations, reagent and flocculant testing
1964	Western Mining Division Research Department of Kennecott Copper Corporation	Independent amenability tests
1967 to 1974	BC Molybdenum	Plant operation
1978	Allis-Chalmers	Grindability tests
1978 to 1982	Amax Metallurgical Laboratory, Golden, Colorado	Metallurgical testwork: Optimization of reagent consumptions, recovery of silver, tungsten, lead and heavy metals as by-products, removal of lead from the molybdenum concentrate, and removal of soluble lead, zinc, cadmium and heavy metals from the concentrator tailings. Addition of a hot acid lead leach circuit was recommended and implemented in late 1981.

Pruebas Metalúrgicas– Capitulo 13

- Inventario de las pruebas utilizadas
- Procedimiento de obtención de muestras
- Discusión de las bases geo-metalúrgicas utilizadas para cada dominio y como fueron establecidas
- Discutir los distintos factores de conminución
- Identificación espacial de las muestras en el rajo

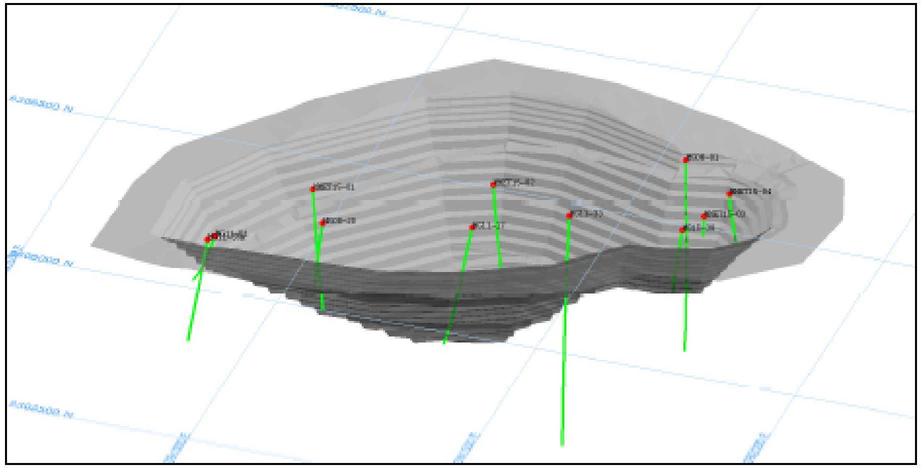


Figure 13-1: MacLellan Drill Hole Locations for Metallurgy Samples
Source: Alamos (2017)

Table 13-1 – Preparation and Interval Selection Summary for 2014/15 Test Program

Description	Units	MacLellan	Gordon
Mineral Resources (PEA, 2014)	Mine Plan (Mt)	18.6	8.4
	Gold Grade (g/t)	1.81	3.06
	Silver Grade (g/t)	3.04	-
Drill holes	DDH (number of)	6	6
Ore Grade (OG)	Total Length (m)	347	218
	Number of Intervals	20	16
	Gold Grade (g/t)	1.90	3.43
	Silver Grade (g/t)	5.0	0.7
Low Grade (LG)	Total Length (m)	140	67
	Number of Intervals	11	5
	Gold Grade (g/t)	0.45	0.53
	Silver Grade (g/t)	2.4	0.2
Benchmarks	ROM (Mt/DDH)	3.1	1.4
	Reserve (oz/interval)	35,000	39,000

Estimación de Recuperaciones– Capitulo 13

- Informar programas metalúrgicos importantes
- Enfocar discusión en los programas mas representativos según la etapa de la ingeniería
- Escenarios estudiados
- Modelo metalúrgicos
  - Consideraciones
  - Suposiciones
  - Validación

$$RCuT = A * \left(B + C * CuT + D * \left(\frac{CuS}{CuT}\right) + E * \left(\frac{CuCN}{CuT}\right)\right)$$

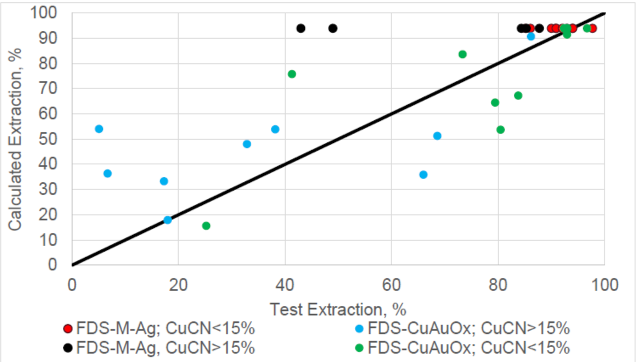
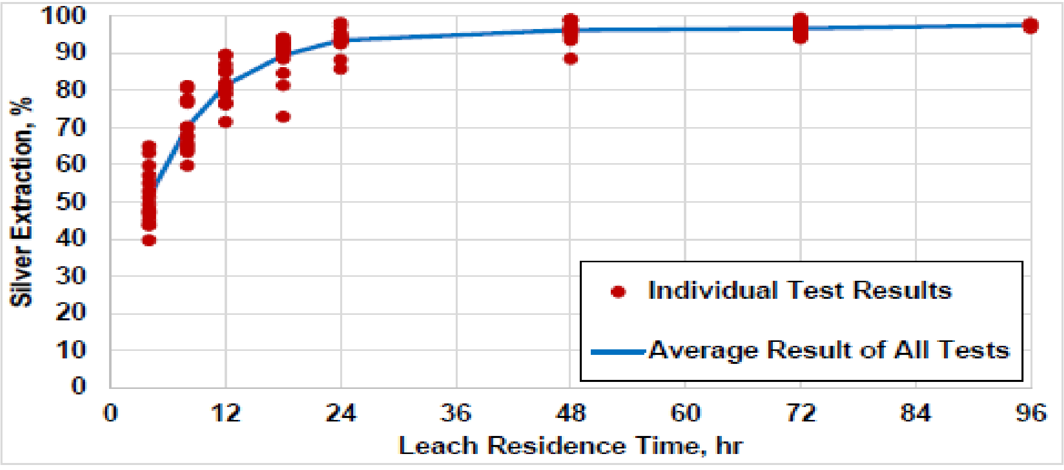


Figure 13-18: FDS CuAuOx Ag extraction calculated vs. BRT result

Table 13-50: Copper Gold Oxide Zones – Summary Conditions

Zone	Head assays			Acid Leach Curing Acid (kg/t)	Cyanide leach Cement (kg/t)
	% Cu	g/t Au	g/t Ag		
TMB CuAuOx	0.41	0.25	0.8	5-25	0
FDS CuAuOx	0.65	0.31	11.8	0-25	0
Copper Blend #1	0.91	0.29	9.4	10	0
Copper Blend #2	0.68	0.32	103	10	0

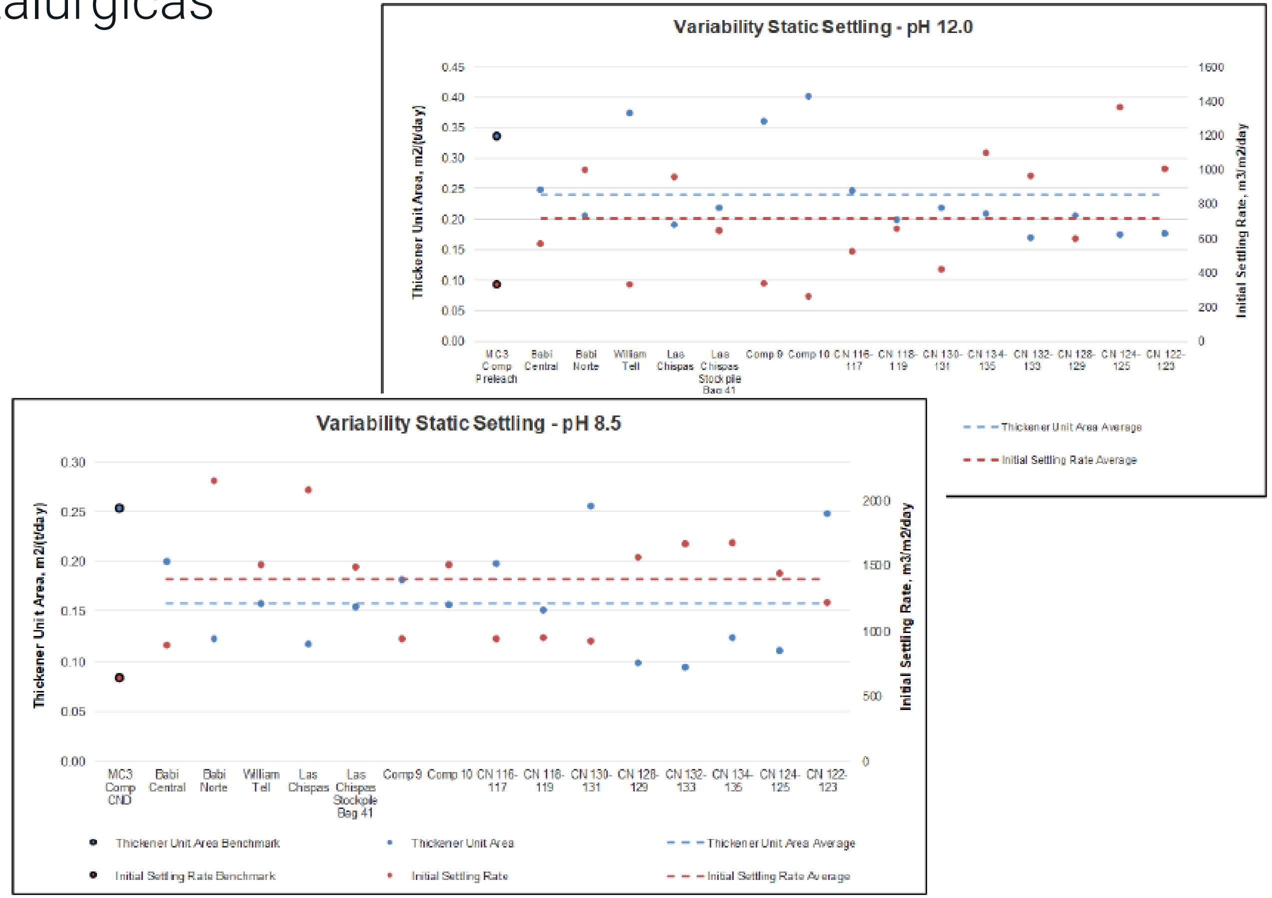


Variabiliad Metalúrgica– Capitulo 13

- Demostrar claramente que las pruebas utilizadas representan la variabilidad del yacimiento
- Discutir la variabilidad muestras geometalúrgicas
- Otras variabilidades
- Identificación espacial de las muestras

Table 13-11: Gravity Concentrate and Tailings Cyanide Leach Test Results – Variability Samples

Sample	Concentrate Extraction		Tail Extraction		Overall Recovery (incl. gravity)		Re-leach Final	
	Au %	Ag %	Au %	Ag %	Au %	Ag %	Au %	Ag %
Babicanora Central	99.7	97.6	94.7	84.5	96.8	88.5	97.4	89.5
Babicanora Norte	98.0	80.1	91.3	95.7	96.3	86.6	97.9	98.5
William Tell	99.0	97.7	97.0	94.4	97.6	95.6	-	-
Las Chispas	99.3	98.7	94.4	96.7	97.4	97.9	-	-
Las Chispas stockpile	96.2	86.2	94.7	98.0	96.0	90.6	-	-
Comp 9	85.3	49.1	96.4	97.6	86.5	71.2	99.4	98.7
Comp 10	96.1	76.0	91.8	90.9	95.3	84.1	98.8	97.0
Babi Sur	99.5	98.7	87.4	86.4	94.6	93.7	95.3	94.4
Babi Vista	97.0	92.6	93.8	96.4	95.8	93.9	97.9	99.0



Note: Figure prepared by SGS Lakefield, 2020.

Ausenco

Elementos Nocivos para el proceso– Capitulo 13

- Proporcionar un comentario específico sobre si se han realizado suficientes pruebas para determinar los grados de los elementos nocivos.
  - Penalizaciones que probablemente se produzcan
  - Mitigación.
- Comentar si se han identificado factores que podrían tener un efecto significativo en la extracción económica potencial.
  - Preg-robbing,
  - Presencia de arcillas
  - Degradación del elemento de interés a largo plazo
  - Necesidad de mezcla para mantener ciertos elementos por debajo de los niveles críticos

Comentarios del Capítulo (QP)– Capitulo 13

- ¿Las pruebas fueron realizadas por laboratorios reconocidos?
- ¿Es el trabajo de prueba apropiado para el estilo de depósito?
- ¿Hay alguna prueba que normalmente se esperaría que no se haya realizado para este nivel de estudio? (estimación de recursos minerales, PEA, PFS, FS)
- Comentar la representatividad compuesta en términos espaciales y de variabilidad
- Comentar los factores de conminución
- Expresar las recuperaciones esperadas de metales/commodities como porcentaje
- Comentar sobre la presencia de cualquier factor que pueda afectar las recuperaciones (p. ej., preg-rob, elementos nocivos)
- ¿El trabajo de prueba sustenta el desarrollo de un diagrama de flujo convencional?
- Si los aspectos del diagrama de flujo son novedosos, ¿cuáles son los riesgos probables en torno al uso de esa tecnología?

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Manejo y mitigación del Riesgo en Ingeniería de Procesos

Metalurgia

Level of Design Definition			
FACTOR	**SCOPING LEVEL**	**PREFEASIBILITY**	**FEASIBILITY**
Intent of Sample Representativity	Indicative	Representative	Comprehensive
Samples Type	Point Samples	Point Samples & Dommain Composites	Domain Samples and Variability Samples (either point or composite)
Identification of Samples in the Report	List to identify sample source and attributes. The QP should comment on how representative the sample is believed to be in terms of grade and domain.	List to identify sample source and attributes. For composites, there should be an explanation of how these are derived. Sample attributes should be reconciled to the resource model to describe the limits of the influence of the sample.	List identifying sample source and attributes. Sample ources typically located on diagram of the deposit.
Information Supporting Process Concept	Concept developed from mineralogy, typical practice for the type of deposit investigated, and selected benchscale tests on samples.	Concept developed from previous information and optimization factor testing of domain composites. On large or complex deposits, key unit operations or novel process steps may be pilot tested under simulated plant conditions. Testing of the impact of grade variance is typically included in the testwork. Testing of metallurgical variance by domain is also a necessary task especially for complex deposits.	Concept brought forward from previous studies and performance confirmed by additional testwork. Key unit operations or novel process steps should be pilot tested under simulated plant conditions. Variability due to grade, domain, and spatial location is determined.
Definition of Saleable Product	Product output must match process selected. Marketability of the product is indicated.	Actual product(s) are produced by testing and marketability is assessed. Identification of deleterious components must be performed, and the impact identified.	Building upon prior work, there is a further demonstration that a product of acceptable quality produced regardless of feed variability. Produced products should undergo market assessment with the exception of bullion products.
Testing QA/QC	Chain of sample custody is demonstrated. Credibility of testing lab is assessed.	Internal QA/QC procedures in testwork should be explained. The ability to duplicate the results of the primary process(es) should be demonstrated.	Internal and external QA/QC procedures in the testwork program are explained. Key tests are duplicated by a reference lab to demonstrate consistent results. Where duplication of tests is not possible, the alternative is an independent peer review.

Diseño del Proceso

Fuente: CIM Guideline Mineral Processing

Level of Design Definition			
FACTOR	**SCOPING LEVEL**	**PREFEASIBILITY**	**FEASIBILITY**
Process Design Criteria (PDC)	Preliminary design criteria used to support resource/reserve modelling are required. These should include tonnage, feed grade, recovery, and major design parameters considered important in the judgment of the QP.	In addition to process design criteria, major design selection criteria for equipment (size, power, type) are established.	Design criteria for process, major equipment and support systems (water, air, HVAC, etc.) are established.
Process Flow Diagram (PFD)	A block flow diagram of the major unit operations showing significant flows is sufficient.	The PFDs indicate the major inputs and outputs of the major unit operation equipment components.	The PFDs show the process flow diagrams of major and minor equipment including bleed and intermittent streams. For large complex projects, P&IDs may be necessary in order to allow for a HAZOP review.
Process Description (PD)	The process should define the concentration or extraction method	Selection of candidate process flowsheet should be confirmed and selection explained. Major components and sizing influences should be described.	Details of major and minor processes within process are provided. This includes major components, power draws and sizing influences.
Equipment List (EL)	Type of equipment is indicated.	Major equipment components are identified.	Major equipment and supporting equipment are identified and power requirements are indicated.
Control & Operations Strategy	None is required.	Basic description should be provided.	The control and operating strategy including strategy in dealing with ore variability should be described.
Material Balance (MB)	A simplified MB should be provided.	A plant MB of the major flows complete with stream densities is provided.	A plant MB of major and minor flows complete with stream characteristics (pH, densities, etc.) product and intermediate grades, is provided.
Energy Balances (EB)		A preliminary energy balance should be constructed indicating ability to source power and the level of consumption.	A detailed energy balance should be constructed indicating ability to source power and the level of consumption.

Evaluación fianciera

Level of Design Definition			
FACTOR	**SCOPING LEVEL**	**PREFEASIBILITY**	**FEASIBILITY**
Level of Capital Expenditures (Capex)	Capex is by factored comparison to similar project in similar location taking into account site location impacts (e.g. elevation, geography). Capex may also be by major equipment quotes and factoring from this basis. **Accuracy is from ±25 to ±50%.**	Capex is determined with major equipment by budgetary quotations, minor equipment from database, and installation costs by factoring. The basis of estimate is developed from database information. Material take-offs developed or indicated as not developed. **Accuracy is ±20%.**	Capex is determined with major equipment by budgetary quotations, minor equipment from database, and installation costs by factoring. The basis of estimate is developed from database information. Material take-offs developed as support. The basis of estimate is developed from local information. Construction and logistical execution plans are developed and support the design. **Accuracy is ±15%.**
Level of Operating Costs (Opex)	Operating cost can be developed by benchmarking for very early stage studies. Where a higher level of category above inferred is being considered, an effort must be made to derive major costs (labour, power, etc.) as would be applied locally to the deposit. **Accuracy is from ±25 to ±35%.**	Operating costs in process are developed from testwork (reagent and energy consumption) and database costing of labour and reagents relevant to the locale. Cost of power is an especially important local cost and its derivation must be identified. **Accuracy is from ±25 to ±15%.**	Process operating costs are developed from testwork (reagent and energy consumption) and database costing of labour and reagents relevant to the locale. Cost of power is an especially important local cost and its derivation must be identified. Individual influence of major operating costs components identified. Supply costs are from local creditable suppliers capable of providing the supplies Labour rates for locals and expatriates must be realistic. Influence of ore variability upon operating costs is identified. Influence of variable operating costs in the financial model is identified. **Accuracy is from ±15 to ±10%.**

"Finding the better way…everyday".

Ausenco

Consultas