Australian Government

Department of Education, Employment and Workplace Relations

MSL975010A Perform fire assay techniques

Revision Number: 1

MSL975010A Perform fire assay techniques

Modification History

Not applicable.

Unit Descriptor

Unit descriptor	This unit of competency covers the ability to safely extract a range of precious metals from their host matrices in readiness for analysis. The unit also covers the ability to select and/or modify laboratory methods to suit particular ores and to ensure total recovery.

Application of the Unit

Application of the unit	This unit of competency is applicable to laboratory personnel working in the mineral assay industry sector. Industry representatives have provided case studies to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting. These can be found at the end of this unit of competency under the section 'This competency in practice'.

Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Prerequisite units		
	MSL954002A	*Prepare mineral samples for analysis*
		OR

Prerequisite units		
	MSL973011A	*Perform fire pouring techniques*

Employability Skills Information

Employability skills	This unit contains employability skills.

Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.

Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1. Classify ore samples and select fluxing method	1.1. Review client request to identify sample/analysis requirements, preparation methods and equipment involved 1.2. Inspect samples, compare with specifications, record and report any discrepancies 1.3. Conduct visual and simple chemical tests to identify the type of sample and sulphide concentrations 1.4. Review client sample/analysis history and identify possible chemical interferences 1.5. Decide whether non-standard fluxing is required 1.6. Select sample weight and flux to optimise precious metal recovery and purity
2. Prepare for precious metal recovery	2.1. Identify hazards and enterprise controls associated with the sample, preparation methods, reagents and equipment 2.2. Examine the recommended preparation method to identify the critical steps that will affect the quality of analytical results 2.3. Plan parallel work sequences to optimise the throughput of multiple sets of samples 2.4. Assemble all required equipments, materials, reagents and check they are fit for purpose
3. Recover precious metals from ore sample	3.1. Weigh required amounts of sample and flux components to achieve an acceptable button and fluid slag 3.2. Select the type and size of pot to suit sample method and client requirements 3.3. Mix charge to ensure homogeneity and optimal collection of precious metal 3.4. Set and monitor furnace temperature/time to ensure complete fusion 3.5. Separate slag and button with minimal loss of lead collector 3.6. Maintain sequencing in order to track samples, buttons and prills throughout the recovery process 3.7. Separate lead collector from the required precious metal and check for contamination, losses and evidence of other precious metals 3.8. Minimise personal exposure to hazards and the release of collectors to the work environment

ELEMENT	PERFORMANCE CRITERIA
	3.9. Collate laboratory documentation and the prepared sample and present for analysis
4. Troubleshoot and correct failed recovery	4.1. Monitor all stages of recovery for indicators of potential loss 4.2. Recognise undesirable recovery conditions and decide whether the process requires correction 4.3. Choose an appropriate corrective action and restart the process 4.4. Document any adjustments made to standard methods and re-sequencing of samples 4.5. Seek advice when problems are beyond scope of responsibility or knowledge
5. Perform daily maintenance of assay equipment	5.1. Segregate and dispose of wastes in accordance with enterprise requirements 5.2. Grade and inspect pots using established criteria prior to storage for re-use 5.3. Inspect furnaces for cracks, unserviceable components and remove slag 5.4. Inspect and clean extractive systems 5.5. Report defective equipment and consumable requirements to appropriate personnel

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- planning and optimising throughput of multiple samples
- accurately weighing samples and flux components
- safely handling heavy/hot items of equipment and hazardous chemicals
- hand-eye coordination during pouring and knocking up buttons
- recognising and identifying the cause of non-acceptable received and fused samples, buttons and prills
- adjusting recovery methods to solve recovery and contamination problems

Required knowledge

Required knowledge includes:

- chemical and physical principles relating to:
  - fusion of mineral ores
  - cupellation
  - parting and digestion processes
- expected physical and chemical properties of materials at each recovery stage
- standard methods for the fire assay of a range of precious metal ores
- hazards and effects of absorption of chemical reagents
- control measures and operation of safety equipment
- function and operation of assay/equipment
- enterprise and/or legal traceability requirements
- relevant health, safety and environment requirements

Evidence Guide

EVIDENCE GUIDE	
The Evidence Guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.	
Overview of assessment	
Critical aspects for assessment and evidence required to demonstrate competency in this unit	Assessors should ensure that candidates can: • recognise hazards and work safely at all times • interpret, follow and adjust (as necessary) standard recovery methods • maintain close attention to technical and safety requirements in a physically demanding/hazardous environment • maintain sequential control of samples through all recovery stages • optimise work flow to ensure efficiency of recovery for multiple client samples • identify indicators of poor recovery • apply a knowledge of mineral chemistry and fire assay techniques to select and implement logical corrective actions to improve recovery rates • minimise rework, waste and environmental impacts • dispose of all waste responsibly.
Context of and specific resources for assessment	This unit of competency is to be assessed in the workplace or simulated workplace environment. This unit of competency may be assessed with: • *MSL975020A Apply routine spectrometric techniques*. Resources may include: • a variety of precious metal ore samples • fire assay methods • fire assay equipment, materials and reagents • safety equipment.
Method of assessment	The following assessment methods are suggested: • review of quality control performance and analytical results traceable to assay samples prepared by the candidate • review of workplace documentation prepared by the candidate

EVIDENCE GUIDE	
	• feedback from peers, clients and supervisors • written/oral questioning about precious metal recovery steps, typical problems and corrective actions. In all cases, practical assessment should be supported by questions to assess underpinning knowledge and those aspects of competency which are difficult to assess directly. Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability. Access must be provided to appropriate learning and/or assessment support when required. The language, literacy and numeracy demands of assessment should not be greater than those required to undertake the unit of competency in a work like environment.
This competency in practice	Industry representatives have provided the case study below to illustrate the practical application of this unit of competency and show its relevance in a workplace setting. **Mineral processing** A fire pourer has noticed a large amount of fine lead shot in the bottom of a pot and seeks advice from the fire assayer. The assayer examines the pot closely and notices a lime green slag colour on the inside of the pot and on the lead button. He/she identifies this as a possible 'chromite' problem and explains that the darker the lime green colour is, the higher the chromium contamination. He/she explains to the pourer that there are two ways of dealing with this problem. The first is to reduce the sample weight to ~5g (for >10% chromite) or to develop its own special flux that has low litharge and silica to ensure that the sample is properly reduced. Because there is no history of regular chromite problems with this particular client's samples, he/she decides that a special flux is not warranted and tells the pourer to reduce the charge weight and to ensure that the components are very well mixed. He/she gives the pourer clear instructions for conducting the repeat assay and documents how the sample was treated.

Range Statement

RANGE STATEMENT	
The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.	
Codes of practice	Where reference is made to industry codes of practice, and/or Australian/international standards, it is expected the latest version will be used

Standards, **codes**, **procedures and/or enterprise requirements**	Standards, codes, procedures and/or enterprise requirements may include:
	• Australian and international standards, such as:
	  • AS 3988-1991 Copper, lead, zinc, gold and silver ores - Guide to sample preparation for the determination of gold
	  • AS 3895.1-1991 Methods for the analysis of copper, lead, zinc, gold and silver ores - Determination of gold (Fire assay-Flame AAS method)
	  • AS ISO 17025-2005 General requirements for the competence of testing and calibration laboratories
	  • AS/NZS ISO 14000 Set:2005 Environmental management standards set
	  • AS/NZS ISO 9000 Set:2008 Quality management systems set
	• calibration and maintenance schedules
	• enterprise recording and reporting procedures
	• enterprise sampling procedures for specific samples, sites and clients
	• environmental legislation and regulations
	• equipment manuals and warranties, supplier catalogues and handbooks
	• equipment startup, operation and shutdown procedures
	• industry codes of practice
	• material safety data sheets (MSDS)

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	• occupational health and safety (OHS) national standards and codes of practice • principles of good laboratory practice (GLP) • production and laboratory schedules • quality manuals, training manuals and induction manuals • standard operating procedures (SOPs) and published preparation methods
Samples	Samples may include: • solids, such as rocks, minerals, soils, sands and stream sediments • core and other drill samples (rotary air blast (RAB), reverse circulation (RC) and aircore) • slurries, powder concentrates and metallurgical solutions • dump samples and grab samples
Client requests/documentation	Client requests/documentation may include: • client profile, sample identification, sample receipt, storage and analyses • required preparation method/and service charges
Assay equipment	Assay equipment may include: • mixing equipment and balances • fusion and muffle furnaces and associated spares • temperature sensors and hotplates • compressed air service, extraction systems and fuel supply lines • pots, cupels, pouring equipment, pot loader, trolleys, moulds, tongs and hammers
Hazards	Hazards may include: • dust, silica, slag, glass shards and molten flux • chemicals, such as hydrofluoric acid, bromine, perchloric acid, aqua regia, cyanide, lead-based compounds, free-mercury and nickel compounds • noise and vibration • crushing, entanglement and cuts associated with moving machinery • manual handling of heavy loads, such as pots,

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	racks and trolleys • heat exhaustion/stress and fatigue
Safety equipment and procedures	Safety equipment and procedures may include: • ensuring access to service shut-off points, fire extinguishers/fire hose, safety shower/eye wash stations and first aid station • recognising and observing hazard warnings and safety signs • labelling of samples, reagents and hazardous materials • direct extraction and fumehoods • guards for moving machinery parts • noise insulation • using personal protective equipment, such as dust masks, heat resistant mittens, safety face shields with tinted visor, coats, ear muffs, safety boots, heat reflective clothing and latex gloves for flux handling • following established manual handling procedures • regular cleaning of equipment and work areas using enterprise procedures • reporting of abnormal emissions, discharges and airborne contaminants, such as noise, light, solids, liquids, water/waste water, gasses, smoke, vapour, fumes, odour and particulars to appropriate personnel

Fluxes	Fluxes may include:
	• bulk fluxes containing PbO, borax, soda ash, silica, silver nitrate and flour
	• non-standard flux additives:
	  • flour (oxidising samples)
	  • nitre (reducing samples, sulphides)
	  • silica (basic ores)
	  • PbO (siliceous ores)
	• exotic additives, such as CaF_2 (refractory ores)
	• NiS ($NiCO_3$, sulphur, borax and soda ash)

Pots	Pots may include: • ceramic, acidic/basic, alumina, zirconia and

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	graphite
Sequencing of pots in a rack	Sequencing of pots in a rack may include: • addition of silver wire • addition of coloured salts (e.g. copper (Cu)) • position of reagent blanks, standards, check samples
Collectors	Collectors may include: • lead (Pb), nickel sulphide (NiS), bismuth (Bi) and tin (Sn)
Criteria for an 'acceptable' button	Criteria for an 'acceptable' button could include: • one piece, mass >20g and <50g • malleable • separates cleanly from slag • free of undecomposed ore, matte and speiss
Separation of collectors	Separation of collectors may include: • cupellation • digestion • parting, annealing and weighing for a gravimetric finish
Contamination	Contamination may be caused by: • poorly made cupels • base metals (copper (Cu), nickel (Ni), zinc (Zn) and bismuth (Bi)) • arsenic (As), sulphur (S), antimony (Sb), selenium (Se), tellurium (Te) and chromium (Cr) • scoria • sprouting
Documentation	Documentation may include: • pour sheets (date, time, client, pour number and preparation method) • number of pots, positions of sample, blank and check in rack • adjustments made to standard preparation methods for specific samples • analytical method • assay data

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Indicators of potential loss and the corrective action	Indicators of potential loss and the corrective action may include: • viscous slag - check furnace temperature, adjust flux and lower charge weight • lead shotting - adjust flux and lower charge weight to compensate for high oxides, silicates and chromites • sulphides - adjust fusion time and adjust sample weight and/or flux • matte, speiss - adjust sample weight and flux • incomplete fusion - adjust sample weight and/or flux • unacceptable button - adjust sample weight and/or flux • inquartation - add 3 parts silver (Ag) to prill, wrap in lead foil and re-cupel
Waste	Waste may include: • rejected pots and cupels • slag and furnace material • disposable personal protective equipment
Occupational health and safety (OHS) and environmental management requirements	OHS and environmental management requirements: • all operations must comply with enterprise OHS and environmental management requirements, which may be imposed through state/territory or federal legislation - these requirements must not be compromised at any time • all operations assume the potentially hazardous nature of samples and require standard precautions to be applied • where relevant, users should access and apply current industry understanding of infection control issued by the National Health and Medical Research Council (NHMRC) and State and Territory Departments of Health

Unit Sector(s)

Unit sector	Testing

Competency field

Competency field	

Co-requisite units

Co-requisite units		