

Selective solvometallurgical leaching of lead and zinc from jarosite residue of the zinc industry

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Abstract: The relatively new branch in extractive metallurgy called solvometallurgy was investigated for selective leaching of Pb and Zn from iron-rich jarosite residue. After screening of several lixiviants, the ionic liquids [A336][Cl] and [C101][Cl] equilibrated with HCl leached the most Pb and Zn. When the ionic liquids were equilibrated with lower HCl concentrations, the dissolution of Fe decreased drastically and thereby the selectivity for Pb and Zn improved. [A336][Cl] equilibrated with 0.5M HCl leached 62 wt% Pb, 27 wt% Zn and 7 wt% Fe. [C101][Cl] equilibrated with 0.5M HCl leached 73 wt% Pb, 31 wt% Zn and 10 wt% Fe.

Introduction

Requirements of Solvometallurgy¹:

- ❖ Lixiviant = organic solvent, organic acid, ionic liquid or deep eutectic solvent ≥ 50 vol %
- ❖ Can contain aqueous solution & mineral acids but in small amount
- ❖ Advantages: reduced energy & acid consumption, Higher selectivity, limited water consumption, suitable for treatment of low grade ores, mine tailings and industrial process residues

- In this work, solvometallurgical leaching was carried out on industrial jarosite residue sample from zinc production plants. Due to its high rate of generation and relative high Pb and Zn content, jarosite could be an important resource for both metals.²

Material Characterization



Drying

Milling



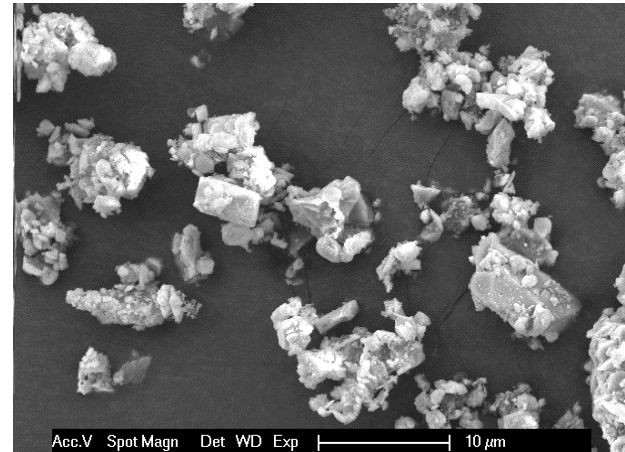
Metal concentration

	Fe	Pb	Zn
Concentration [g/kg]	175	40	24

Mineralogy

- PbSO₄
- ZnS
- NaFe₃(SO₄)(OH)₆

Particle size < 240 μm

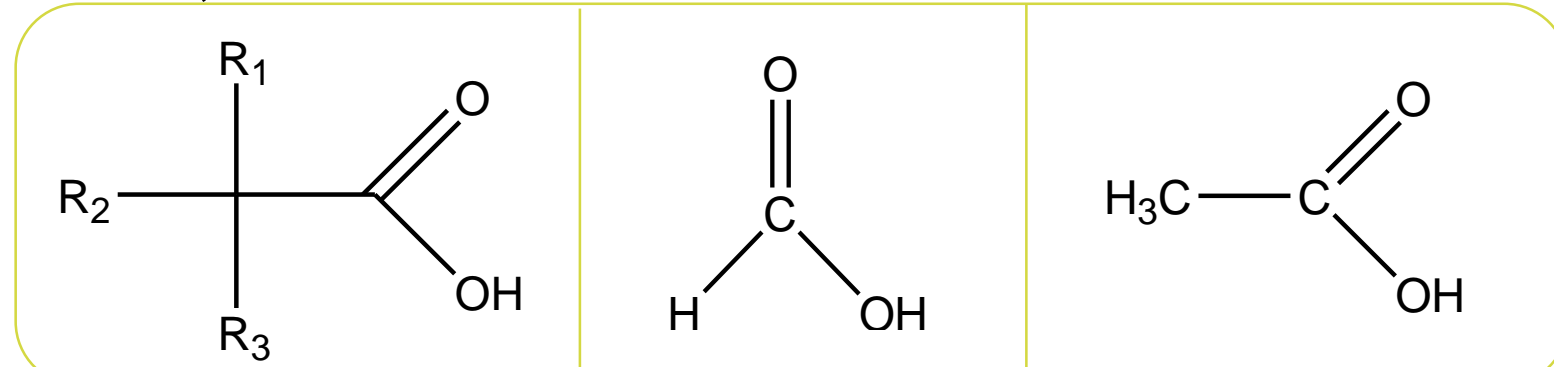


Lixiviants

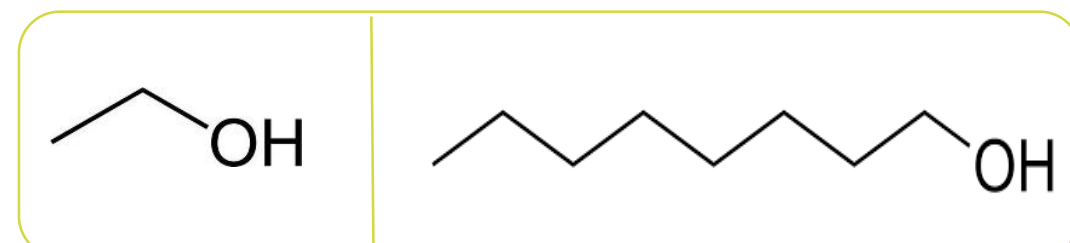
Lixiviant = leaching agent + diluent

- ❖ **Diluent:** to reduce the viscosity of leaching agent
- ❖ **Leaching agents:** to selectively leach the metals

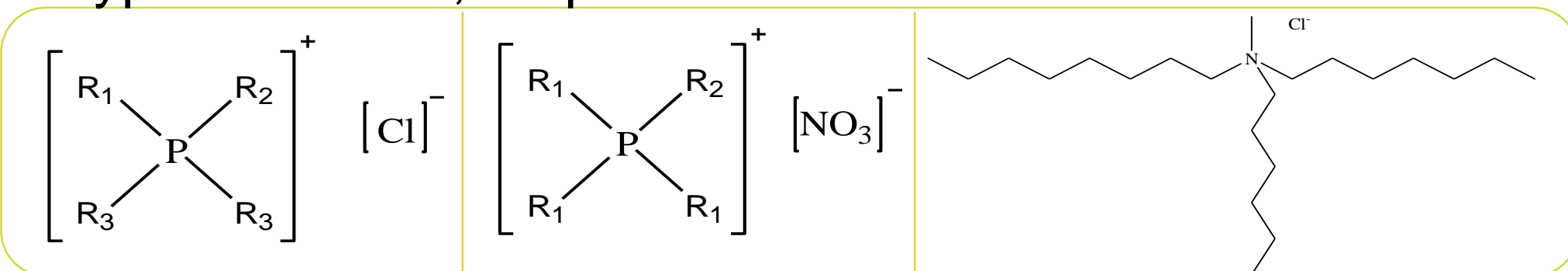
Organic acid: e.g. versatic acid, formic acid, acetic acid



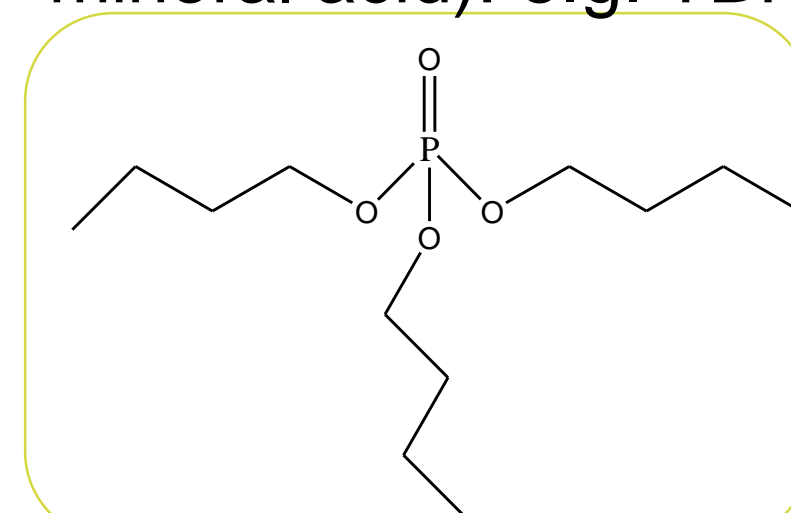
Alcohol with dissolved mineral acid



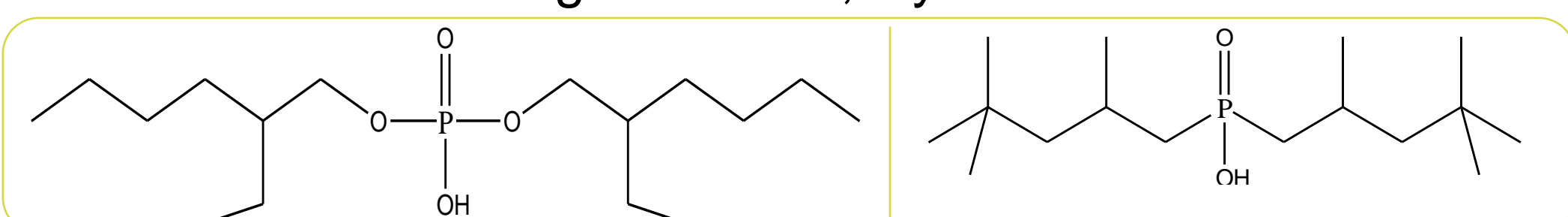
Basic extractant (saturated with mineral acid): e.g. Cyphos® IL 101, Aliquat® 336



Neutral extractant (saturated with mineral acid): e.g. TBP



Acidic extractants: e.g. D2EHPA, Cyanex® 272

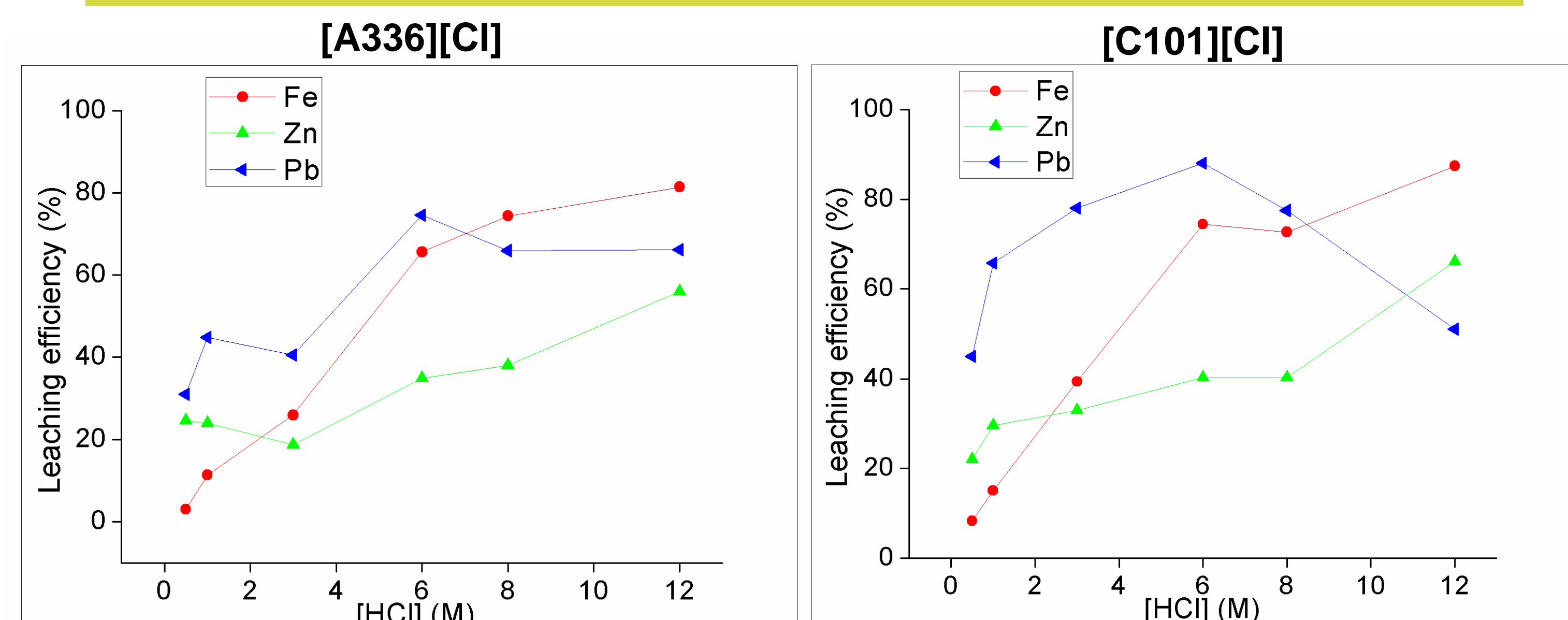


Results

Finding the best lixiviant

No.	Lixiviant	Pb [mg/L]	Zn [mg/L]	Fe [mg/L]
1	Formic acid (undiluted)	0	110	2101
2	Acetic acid (undiluted)	0	15	934
3	Versatic acid (undiluted)	0	0.4	3
4	Di-(2-ethylhexyl)phosphoric acid (D2EHPA) (undiluted)	0	29	580
5	Cyanex 272 (equilibrated with water)	0	134	150
6	Cyanex 272 (unequilibrated)	0	37	90
7	[A336][NO ₃] (equilibrated with 5M HNO ₃)	0	24	2
8	[C101][NO ₃] (equilibrated with 5M HNO ₃)	0	157	207
9	Ethanol (undiluted)	0	67	639
10	1.2 M HCl in ethanol	11	688	3450
11	5.4 M HCl in 1-octanol	117	660	11000
12	TBP equilibrated with 12M HCl	166	928	15757
13	[A336][Cl] equilibrated with 12M HCl	722	952	12978
14	[C101][Cl] equilibrated with 12M HCl	2615	1316	14272

[A336][Cl] & [C101][Cl] equilibrated with different HCl concentration

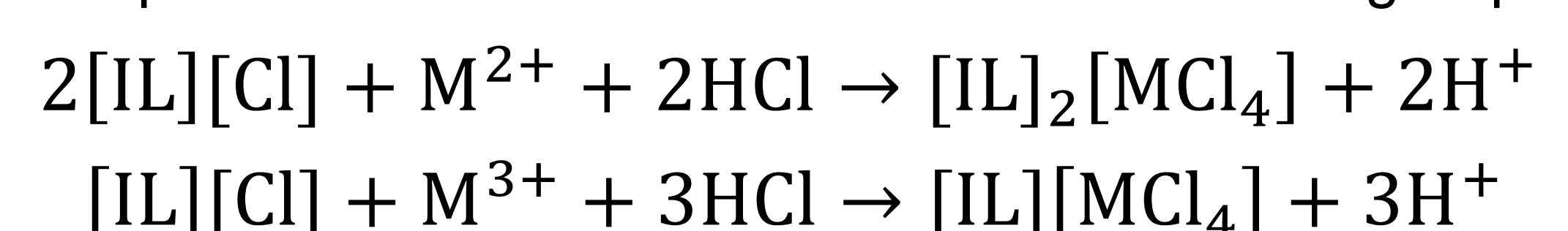


Leaching efficiencies at optimized leaching parameters

Lixiviant	Pb [%]	Zn [%]	Fe [%]
[A336][Cl] eq. with 0.5M HCl	62	27	7
[C101][Cl] eq. with 0.5M HCl	73	31	10

Retention time: 2 hrs, temperature: 45 ° C, Solid/liquid ratio: 1/15 g/ml, and stirring speed: 1500 rpm

The dissolution process can be summarized into the following equation:



Conclusion

- The presence of HCl in the lixiviant is critical for leaching Pb from jarosite. All the lixiviants without HCl did not leach any Pb.
- [A336][Cl] and [C101][Cl] equilibrated with HCl leached the highest amount of Pb and Zn. The selectivity towards some metals is strongly influenced by the concentration of HCl used for equilibrating the ionic liquid.
- The selective leaching of Pb (62–73%) and Zn (27–31%) against Fe (7–10%) took place with [A336][Cl] and [C101][Cl] after equilibration with 0.5 M HCl. When the ionic liquids ([IL][Cl]) were equilibrated with higher concentrations of HCl, the Fe dissolution increased more than the valuable metal dissolutions and, thus resulted in a poor selectivity.

1. K. Binnemans and P. T. Jones, "Solvometallurgy: An Emerging Branch of Extractive Metallurgy", *Journal of Sustainable Metallurgy*, **3**, 570–600 (2017).

2. K. Binnemans and P. T. Jones, "Towards zero-waste valorisation of landfilled stocks and fresh flows of critical-metal-containing industrial process residues: a critical review", *Proceedings of the Third International Academic Symposium on Enhanced Landfill Mining (ELFM III)*, Lisboa (Portugal), 8-10 February 2016, pp 150-173.