



Commercial Lunar Ice Mining: Is There a Role for Royalties?

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Some Context

- **Understanding fiscal regime for commercial resource projects is key for investors**
 - E.g. Effective Tax Rate (ETR) for mining projects typically 40-60% of project value
- **‘Benefit of Mankind’ a key discussion point since signing OST in 1968**
 - Ambiguity around space resource benefit sharing
- **UN COPUOS legal subcommittee exploring legal models for commercial space resources**
 - Should include ‘...an equitable sharing by all States in the benefits derived from [space] resources....’
 - Monetary / non-monetary benefit sharing?



Resource taxes and royalties account for a large slice of the economic pie...

Ask the Question – is monetary benefit sharing worth considering?

- Could the economics of a space resources project tolerate a material fiscal regime?
- Could the potential benefits be meaningful?
- What are the potential impacts on operational factors?



SHOW ME THE NUMBERS!

Show me the numbers – How?

- **Impact of taxes & royalties on indicative investment metrics for single project?**
 - Compare impact on post tax Minimum Acceptable Investment metrics
- **Determine cumulative per capita share over 50 yrs**
 - 50 yr growth rates (2 – 10% pa) applied to project royalties
 - Benefit allocation for 4 countries (World Bank categories) / Allocation share from ISA
- **Illustrative impact on operational factors**
 - Generated cut off grade / mass graphs for 2 indicative resource types
 - Applied royalties to determine impact on resource & economics



Credit: ULA
Simplified DCF financial model based on NIAC Thermal Ice Mining Concept (ref [1])

Minimum Acceptable Investment Metrics (MAIM)

Post tax & royalty IRR = 20%

Post tax & royalty NPV_{10%} = \$700m

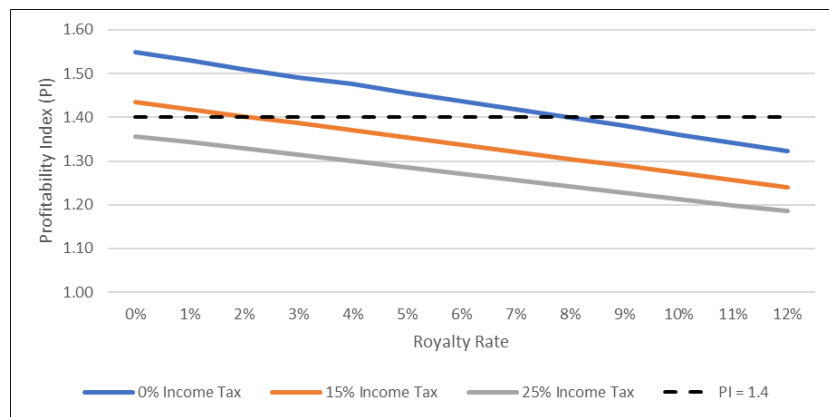
Post tax & royalty PI = 1.4

¹ Sowers, G., *NASA Innovative Advanced Concepts (NIAC) Phase I study: Thermal Mining of Ices on Cold Solar System Bodies*. 2020, Colorado School of Mines.

Impact on Single Project Economics

- Hypothetical project could tolerate c.2% royalty at 15% tax rate / c.8% royalty at 0% tax rate
- Project could tolerate ETR of 20-25% (compares to typical mining ETR of 40-60%)

Minimum Acceptable Investment Metric (MAIM)	Tax rate	Max Royalty Rate for MAIM
Post tax & royalty IRR = 20%	0%	9%
	15%	4%
	25%	N/A
Post tax & royalty NPV _{10%} = \$700m	0%	8%
	15%	2.5%
	25%	N/A
Post tax & royalty PI = 1.4	0%	8%
	15%	2%
	25%	N/A



Post tax & Royalty PI by Tax Rate & Royalty Rate



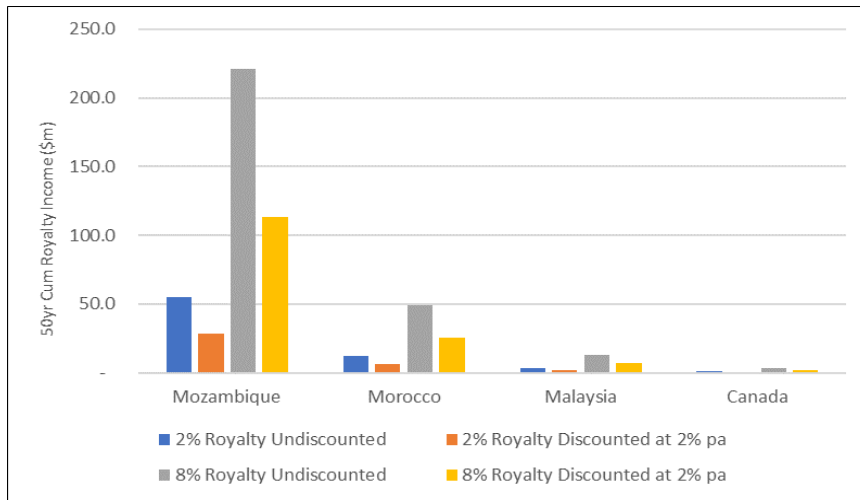
ETR by Tax and Royalty Rate

Industry royalty benefits generated over 50 years

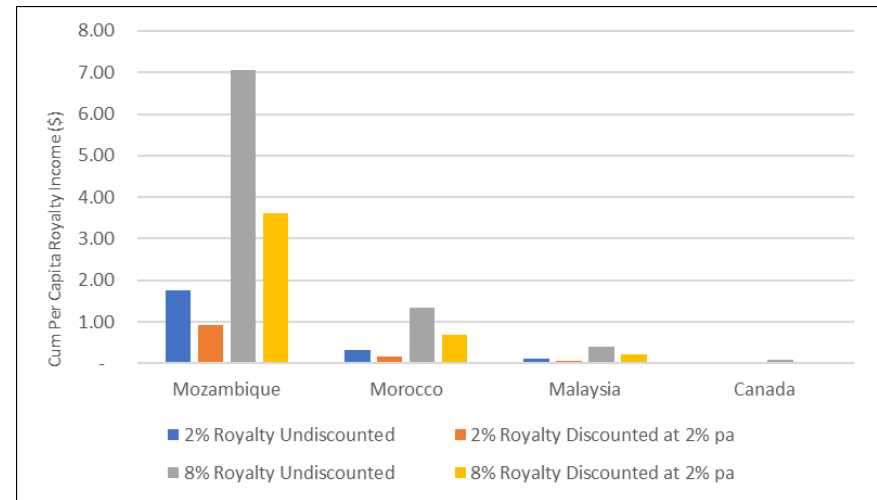
- 50 yr cumulative per capita royalty (8%) for Mozambique with 6% p.a. industry growth rate is <\$10 total
- Weighted to end of 50 yr period

Country	World Bank Group	2017 GNI / Capita (\$)	Population 2021 (M)	Allocation Share
Mozambique	LIC	\$560	31.3	0.01729
Morocco	LMIC	\$3,068	36.9	0.00386
Malaysia	UMIC	\$10,172	32.4	0.00103
Canada	HIC	\$48,838	37.7	0.00025

Allocation Share and Population for Four Countries



Indicative 50 year Aggregate Royalty Revenue for Select Countries at 6% Growth Rate



Indicative 50yr Aggregate Per Capita Royalty Revenue for Select Countries at 6% pa Growth Rate

Some Discussion Points

- Interplay between royalty rate and tax rate important to address
- Difficult to see how social licence considerations could be addressed through royalties
- Understanding interplay with geology and operations would be important if royalties were ever considered
- Impact on ability to raise funding?

Conclusion – our view

- Limited sense in imposing royalties for benefit sharing in foreseeable future
- Reaffirms view that focus should be on non-monetary benefit sharing
- But: if royalties are considered, potential impact on commercial and technical considerations will be important to explore
- Hypothetical research at this point – but similar approach may be needed with more concrete data over time