



Vanadium Technology Pathways

Flow Battery Symposium

UNSW – 16 October 2024

Tivan: Corporate Profile

- Tivan (TVN) is an ASX listed critical minerals company headquartered in Darwin
- Renamed (previously TNG) in January 2023, following a change of control
- Tivan acquired the Speewah Project in February 2023
- Major Projects:
 - Speewah Fluorite Project, in Strategic Alliance with Sumitomo Corporation
 - Sandover Project, an exploration Alliance with EARTH AI (Ag, Pb, Li, Cu, W)
 - Speewah VTM Project: Salt Roast / TIVAN+ technology, in strategic partnership with CSIRO
 - Middle Arm Sustainable Development Precinct (Darwin) - proposed vanadium electrolyte facility



Figure 1: Tivan's Projects across central and northern Australia.

Tivan: Speewah is Australia's premier VTM resource

Background:

Tivan acquired Speewah in Q1 2023 following an extensive review of global VTM resources.

Development Pathway:

Tivan has pursued two development pathways: Salt Roast & TIVAN+ critical minerals technology with CSIRO.

Attributes:

- Largest drilled vanadium titanomagnetite resource globally
- Very high vanadium concentrate grade & recovery
- Ultra long-life resource, with low strip ratio (0.4)
- Proximity to the Port of Wyndham & MASDP
- Proximity to large-scale hydro and solar resources

Staged Development Project:

- The Speewah Fluorite Project will introduce critical infrastructure and facilitate the Speewah VTM Project.

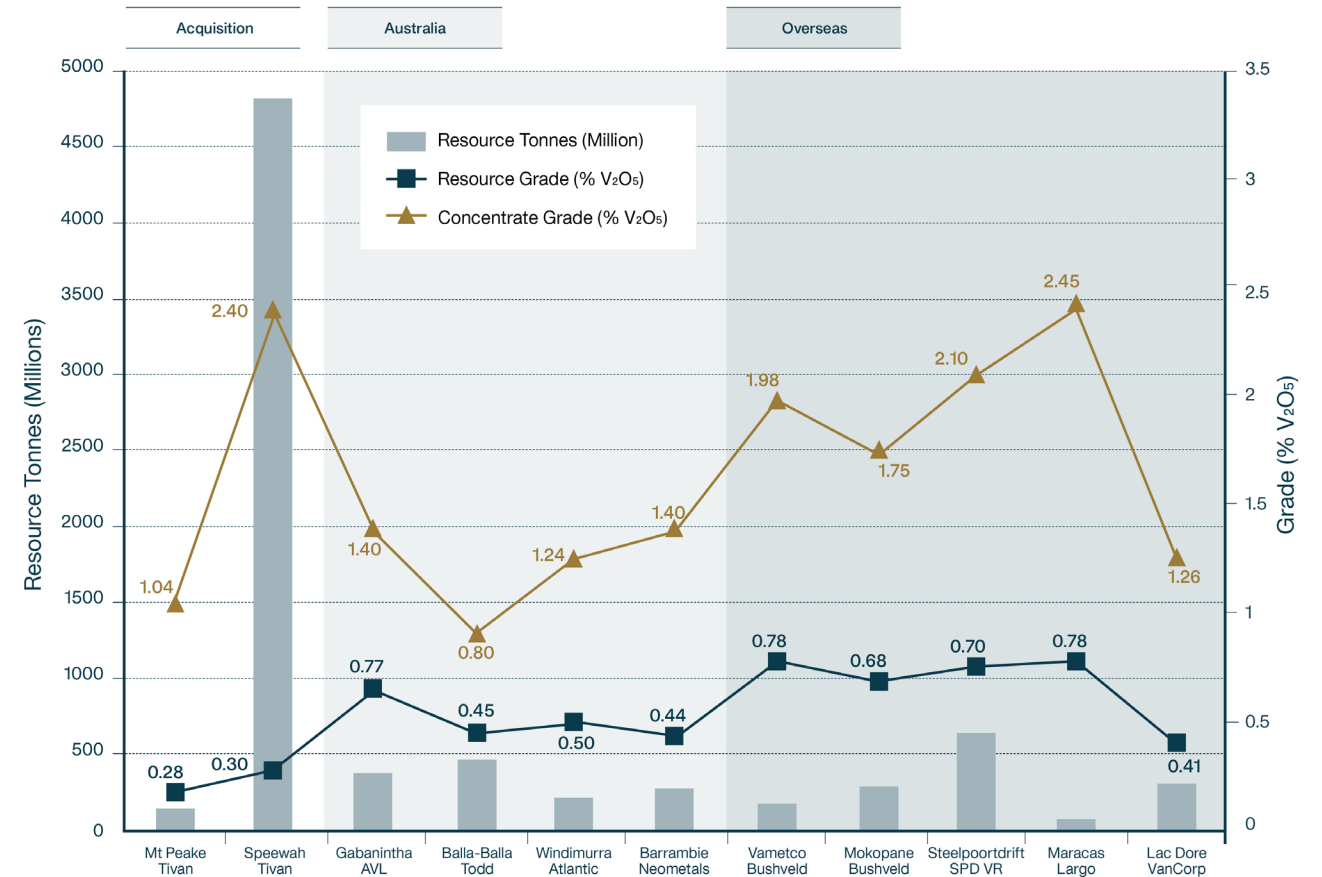


Figure 2: Vanadium in titanomagnetite resources, peer comparison. Prepared in accordance with ASX Compliance Update, 19 September 2018. Update No 08/18, Section 3. [Link](#) is available here. The full dataset with relevant sources and notes is included in Appendix.

Tivan: Strategic R&D Partnership with CSIRO on TIVAN+ Technology

Background:

Tivan & CSIRO agreed a long-term strategic partnership to develop and commercialise the TIVAN+ technology in November 2023. TIVAN+ aims to produce three commercial grade products in Vanadium, Titanium and Iron from VTM resources, commencing at Speewah.

Agreements:

Technology Licence Agreement (20 years)
Research Services Agreement.

Attributes:

- Industry leading R&D collaboration with Tivan & CSIRO pooling developmental resources
- Testwork program using Speewah ore completed in May 2024, with high grade results achieved in vanadium precursor and magnetite
- Well defined project pathway to achieve FID on TIVAN+ Pilot Plant over 18 months
- Third party interest in TIVAN+ Pilot, including in Australia

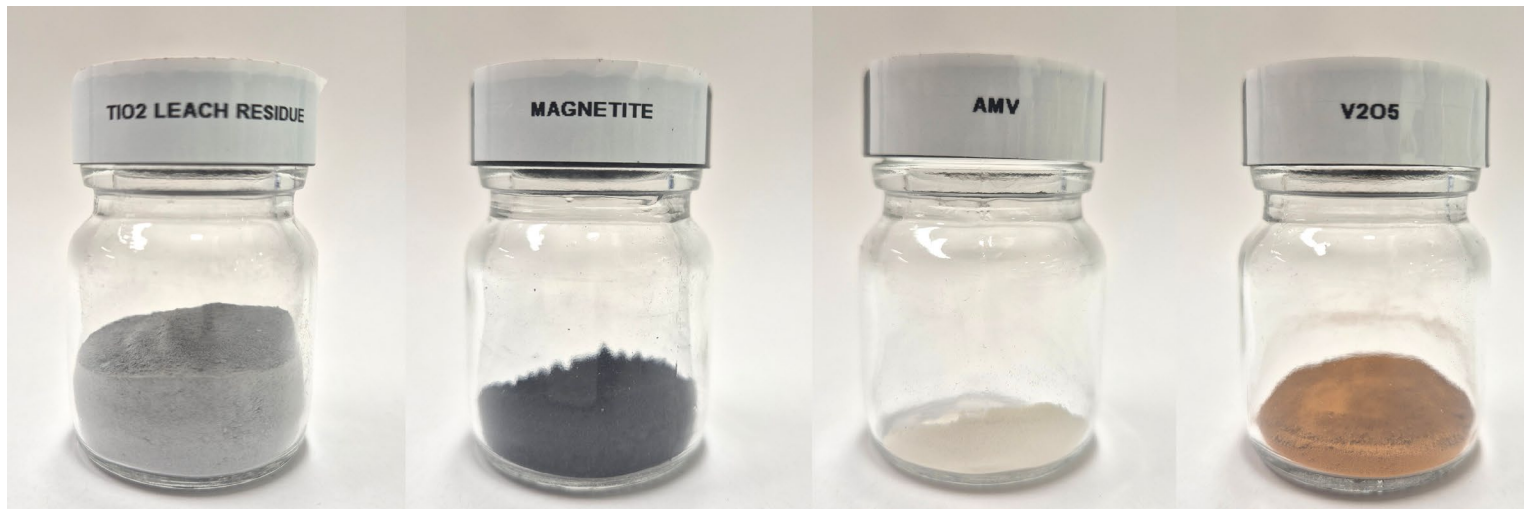


Figure 3: Samples – titanium dioxide (leach trials), magnetite (iron recovery trials), “AMV” (ammonium metavanadate is a pre-cursor to V_2O_5 preparation) and vanadium pentoxide (vanadium recovery trials).

(Source: CSIRO, May 2024)

Tivan: Strategic R&D Collaboration with Sumitomo Electric Industries and UNSW

Background:

Tivan is completing a testwork program to achieve VRFB specifications provided by Sumitomo Electric Industries (SEI) using on Speewah ore.

Testwork Interim Results:

Testwork results for salt roasting have exceeded expectations, demonstrating that the Speewah ore has high amenability to salt roasting

- Vanadium extractions up to 98.3%, a large uplift (~6%) on previous results
- Vanadium extractions greater than 97% demonstrated as repeatable outcome in testwork with industrially relevant processing parameters
- Very low impurity dissolution for Fe, Ti, Al, Cr, Mn and Mg
- Purification and vanadium precipitation testwork program in progress at ALS
- Vanadium electrolyte testing will be conducted by UNSW under Trailblazer Recycling and Clean Energy Program

July		August			September			October			November			December			
		Downstream Purification and Vanadium Precipitation															
												Vanadium Electrolyte Works					

Figure 4: Salt roasting and vanadium electrolyte production testwork program. Schedule is indicative only and subject to risk of delay.

Tivan: Vanadium Electrolyte Specifications

Product type	Composition		Permissible variation
3-valent electrolyte	V	≥ 1.50 mol/L	± 0.05 mol/L
	SO ₄ ²⁻	≥ 2.30 mol/L	± 0.10 mol/L
	V ³⁺ : VO ²⁺	≥ 0.95	
3.5-valent electrolyte	V	≥ 1.50 mol/L	± 0.05 mol/L
	SO ₄ ²⁻	≥ 2.30 mol/L	± 0.10 mol/L
	V ^{3.5+} : V	1.0	± 0.10
4-valent	V	≥ 1.50 mol/L	± 0.05 mol/L
	SO ₄ ²⁻	≥ 2.30 mol/L	± 0.10 mol/L
	VO ²⁺ : V	≥ 0.95	

- Currently no International or Australian Standard for Vanadium Battery Electrolytes.
- Each Vanadium Flow Battery producer has proprietary electrolyte specification that they are not willing to share.
- This creates difficulties for electrolyte producers and increases electrolyte production costs
- Chinese standard often used as reference

产品品种	成分		允许偏差
3.5 价电解液	V	≥ 1.50 mol/L	± 0.05 mol/L
	SO ₄ ²⁻	≥ 2.30 mol/L	± 0.10 mol/L
	V ³⁺ + VO ²⁺	1.0	± 0.10
4 价电解液	V	≥ 1.50 mol/L	± 0.05 mol/L
	SO ₄ ²⁻	≥ 2.30 mol/L	± 0.10 mol/L
	VO ²⁺ + V	≥ 0.95	

3.3 杂质元素含量
 产品中的杂质元素含量应符合表 2 的规定。需方如对产品的杂质元素含量有其他要求时，在订货单(或合同)中注明。

表 2 杂质元素含量 (单位为毫克每升)

杂质元素	一级	二级
Al	50	80
As	1	1
Au	1	1
Ca	30	70
Cl	100	-
Cr	15	30
Cu	1	5
Fe	50	200
K	100	200
Mg	20	50
Mn		30
Mo	20	30
NH ₄ ⁺	20	50
Na	80	200
Ni	20	60
Pd	1	1
Pt	1	1
Si	10	-

Impurity element	Grade 1 No greater than	Grade 2 No greater than
Al	50	80
As	1	1
Au	1	1
Ca	30	70
Cl	100	-
Cr	15	30 (Not clear)
Cu	1	5
Fe (Not clear)	50	200
K	100	200
Mg	30	50
Mn	1(Not clear)	30
Mo	20	30
NH ₄ ⁺	20	50
Na	80	200
Ni	20	60
Pd	1	1
Pt	1	1
Si	10	-

Figure 5: Chinese standard

Tivan: Partners

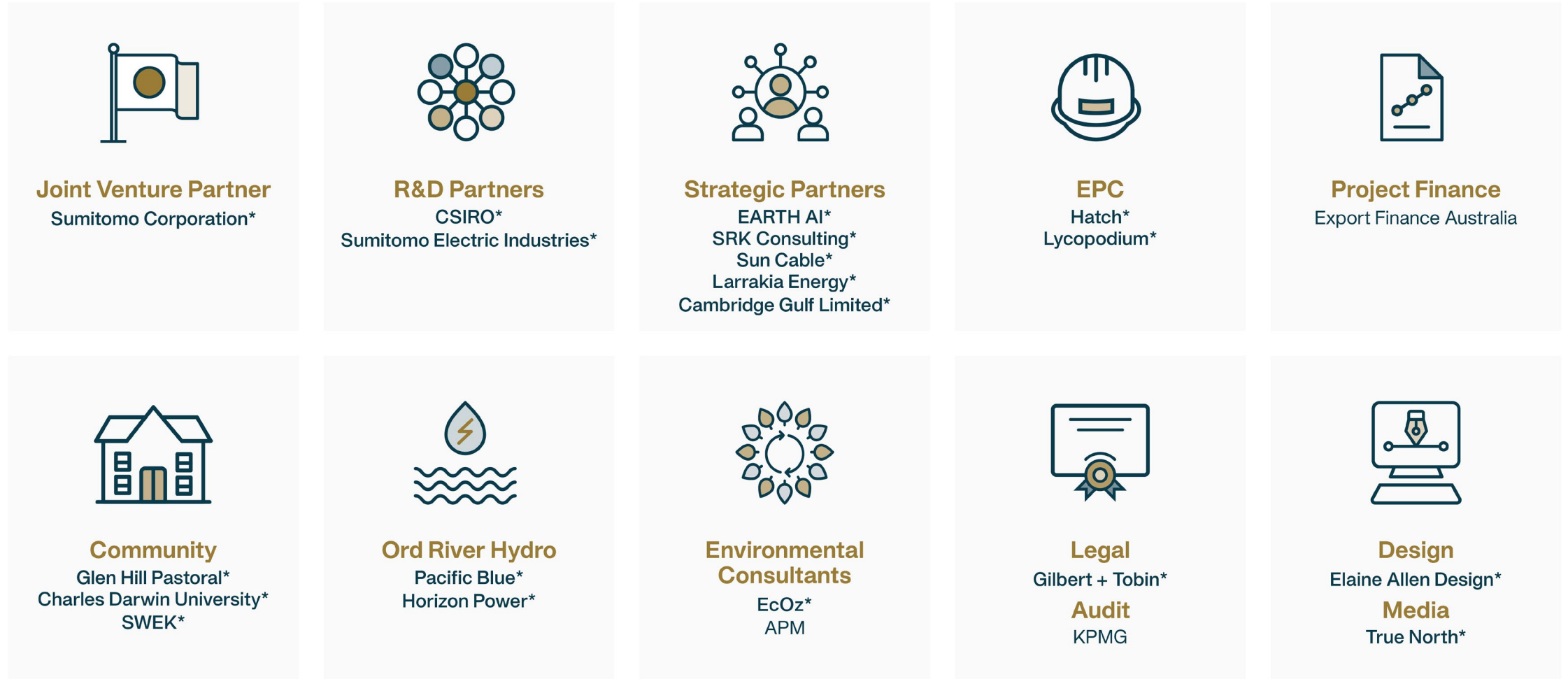


Figure 6: Tivan's partners *new era

Tivan: Appendix – Hard Rock Vanadium Peer Comparison

For live links:  [Read here](#) ASX Announcement dated 20th February 2023

Acquisition		Australia			Overseas					
Company	Code	Deposit	Location	Stage	Resource Category	Resource (Mt)	Resource Grade (V2O5%)	Total Resource (Mt V2O5%)	Concentrate Grade	Sources and Notes
Tivan	ASX: TVN	Mount Peake	NT	Development	Measured	118.0	0.29	160Mt @ 0.28% (Cutoff V2O5% 0.10%)	1.04	ASX announcement 24 January 2023 Quarterly Activities Report, TNG investor presentation https://tivan.com.au/wp-content/uploads/2023/02/61132915-1.pdf https://www.asx.com.au/asxpdf/20190604/pdf/445lqv6lxy90gf.pdf
					Indicated	20.0	0.28			
					Inferred	22.0	0.22			
Tivan	ASX: TVN	Speewah	WA	Development	Measured	322.0	0.33	4712Mt @ 0.30% (Cutoff V2O5% 0.23%)	2.40	ASX announcement 1 April 2019, 10 May 2022, 22 September 2022 https://app.sharelinktechnologies.com/announcement/asx/4fd202b184aafb93bc7350413f16d283 https://app.sharelinktechnologies.com/announcement/asx/5f6090d1a01816a20d24a633a15ecb20 https://app.sharelinktechnologies.com/announcement/asx/41ad6aa2b6c9b0c09cb45d6b2046327d
					Indicated	1,054.0	0.30			
					Inferred	3,335.0	0.29			
AVL	ASX: AVL	Gabanintha	WA	Development	Measured	30.6	1.13	395.4Mt @ 0.77% (various cutoffs)	1.40	ASX announcement 7 May 2024
					Indicated	136.6	0.85			
					Inferred	228.2	0.66			
Todd Resources	Private	Balla Balla	WA	Development	Measured	219.0	0.64	456Mt @ 0.64% (Cutoff V2O5% 0.30%)	0.80	Integrated feasibility study December 2009. ASX disclosure 16 December 2011. https://www.asx.com.au/asxpdf/20111216/pdf/4239v45c02k79t.pdf https://drive.google.com/file/d/1wGS4cibLxmYmTnnltz39T_n5uoU1W0LH/view
					Indicated	86.7	0.63			
					Inferred	150.2	0.64			
Atlantic	Private	Windimurra	WA	Development	Measured	34.6	0.49	210Mt @ 0.50% (Cutoff V2O5% 0.28%)	1.24	2019 Mineral Resource Estimate https://atlanticptyltd.com.au/projects/windimurra/geology-reserves-resources
					Indicated	123.5	0.50			
					Inferred	51.6	0.50			
Neometals	ASX: NMT	Barambie	WA	Development	Measured	n/a	n/a	280Mt @ 0.44% (Cutoff V2O5% 0.20%)	1.40	ASX announcement 17 April 2018 Updated Barambie Mineral Resource Estimate https://wcsecure.weblink.com.au/pdf/NMT/01971759.pdf
					Indicated	187.0	0.46			
					Inferred	93.0	0.40			
Bushveld	LSE: BMN	Vametco	South Africa	Production	Measured	n/a	n/a	183Mt @ 0.78% (Cutoff = 0.20% magnetite)	1.98	Vametco Inferred & Indicated Mineral Resource and Ore Reserve Update for Annual Reporting https://www.bushveldminerals.com/wp-content/uploads/2022/04/J4590-Vametco-Mineral-Resources-and-Ore-Reserves-31-December-2021-Dated-30-Mar-2022.pdf
					Indicated	140.1	0.74			
					Inferred	42.6	0.90			
Bushveld	LSE: BMN	Mokopane	South Africa	Development	Measured	n/a	n/a	297Mt @ 0.68% (Cutoff V2O5 = 0.30%)	1.75	Mokopane Vanadium project Pre-Feasibility Study 30/10/16 http://bushveldminerals.com/wp-content/uploads/2017/08/201602040458050.pdf
					Indicated	63.2	1.32			
					Inferred	234.0	0.51			
SPD VR	ASX: VR8	Steelpoortdrift	South Africa	Development	Measured	145.5	0.72	680Mt @ 0.70% (Cutoff V2O5 = 0.45%)	2.10	ASX announcement 17 November 2022. Investor Presentation May 2022. https://vr8.global/sites/default/files/2022%2005%2009%20Vanadium%20Resources%20Investor%20Presentation%20.pdf
					Indicated	327.3	0.70			
					Inferred	207.4	0.68			
Largo Resources	NASDAQ: LGO TSX: LGO	Maracas	Brazil	Production	Measured	45.9	0.83	79Mt @ 0.78% (Cutoff V2O5 = 0.30%)	2.45	43-101 Technical Report 10 October 2021 https://s29.g4cdn.com/562286712/files/doc_downloads/technical_report/marac%C3%A1s_menchen_mine/TR_GE21_Largo_43101_16122021_Final-Version-Conformed-for-Filing.pdf
					Indicated	17.7	0.70			
					Inferred	15.5	0.74			
Lac Dore	TSX: VRB	VanCorp	Canada	Development	Measured	24.0	0.50	304.9Mt @ 0.41% (Cutoff V2O5 = 0.30%)	1.26	Lac Dore Mineral Resource Estimate 29 October 2020 https://www.vanadiumcorp.com/releases/vanadiumcorp-reports-the-lac-dore-mineral-resource-estimate-mre-2/
					Indicated	191.0	0.40			
					Inferred	89.9	0.40			

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tivan
a critical minerals company

Registered Office

Level 1, 16 Bennett Street
Darwin NT 0800 Australia

Contact

+61 8 9327 0900
engagement@tivan.com.au

tivan Limited

ABN 12 000 817 023
ASX Code: TVN

tivan.com.au