

# AVL LODGES INTERNATIONAL PATENT APPLICATION FOR VANADIUM PROCESSING CIRCUIT

*Unique processing route under international patent application.*

## KEY POINTS

- Following a provisional patent application submission in 2021<sup>1</sup>, AVL has progressed to filing a full international patent application to assist with the protection of intellectual property (IP) generated during the Bankable Feasibility Study (BFS).
- The IP applies to AVL's processing circuit, which comprises an innovative combination of processes to maximise vanadium recovery.
- A distinctive feature of the patent application is the ability to economically recover vanadium from oxidised and transitional zones common to VTM deposits worldwide.
- The pyrometallurgy process utilises pelletisation and a grate-kiln for roasting, which has been shown to considerably improve vanadium extraction in comparison to conventional roasting.
- The hydrometallurgy process includes a washing stage to produce a clean iron titanium coproduct.
- A combination of nanofiltration and solvent extraction generates ultra-high purity vanadium for specialty applications.
- The patent application is recognised across 156 countries through the Patent Cooperation Treaty (PCT).
- Work contributing to this patent application was partly funded by the Australian Government's CRC-P grant<sup>2</sup>.

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<sup>1</sup> See ASX announcement dated 12<sup>th</sup> April 2021 'AVL Lodges Patent Application for Vanadium Processing Circuit'

<sup>2</sup> See ASX announcement dated 10<sup>th</sup> February 2020 'AVL Awarded \$1.25 Million Vanadium Research and Development Grant'

Australian Vanadium Limited (ASX: AVL, “the Company” or “AVL”) is pleased to advise that it has filed an international patent application for its unique vanadium processing route. The patent application’s International Application Number is PCT/AU2022/050315. The international patent application follows on from the provisional application filed in April 2021 and includes updated details generated during the BFS piloting in 2021. It is anticipated that the patent application and patent once granted will help to provide protection for the Company and its shareholders for the unique and efficient processing design. The inclusion of a saleable iron-titanium coproduct (FeTi coproduct) also contributes to the uniqueness of this process. The basis for the patent application is the specific sequence of beneficiation, pyrometallurgy and hydrometallurgy that combine to produce a high purity vanadium product with exceptional recoveries.

Managing Director, Vincent Algar, comments, *“The processing patent application by AVL is another important milestone along the way to production for the Company, further enabling the development of the Project, and meeting growing demand for vanadium globally. One of AVL’s many strengths is the depth of vanadium knowledge within the team and its associates. The innovative work by the team during the study phase has culminated in an insightful processing circuit that has benefits to AVL and the wider vanadium industry.”*

### **Progress since provisional patent application submission**

The previous submission of the provisional application established a priority date for the invention of April 2021. After the provisional patent submission, a global search of the databases of international patent authorities was conducted by Wrays Patent and Trademark Attorneys.

With a focus on existing patents in the field of vanadium ore processing and extraction, the search results confirmed the uniqueness of AVL’s beneficiation and extraction processes and the need for the protection a patent can provide for the Company’s IP. This process was necessary to fulfil one of AVL’s objectives, which is to protect the Company’s inventions as they will be applied in the development of the Project and to facilitate licensing of the beneficiation and extraction technology to other vanadium producers who are developing their own extraction capabilities.

### **Details of the international patent submission**

Vanadium extraction from vanadium bearing titano-magnetite (VTM) ores, such as AVL’s, has been achieved through well-known, standardised roast-leach and precipitation routes since the 1950s. Standard VTM processing involves production of a magnetic concentrate, which is then roasted with sodium salts to produce a water-soluble vanadium salt. This is then leached in water via tanks or vats, precipitated and converted to vanadium pentoxide. VTM ores can also be processed in steel mills, with the vanadium reporting to the slag. The slag is then subjected to the roast leach process for vanadium recovery. This is the dominant method used in China.

A few novel processes have been patented for treating VTM ores and generally involve beneficiation, followed by hot acid leaching and multiple separation stages to produce separate vanadium, titanium and iron products. These processes also rely on new technologies that are yet to be established and carry considerable risk. Consequently, these processes have been in the development stage for many years and are yet to be implemented commercially.

By contrast, AVL has built on established beneficiation and roast-leach technologies with step-change improvements to deliver superior vanadium recoveries. AVL's beneficiation process comprises a combination of magnetic separation and reverse flotation that can maximise recovery from oxidised ores and fresh-transition-oxide ore blends to produce a low silica concentrate for roasting. The AVL roast-leach process incorporates pelletisation, which allows an intimate contact between the concentrate and reagents prior to drying and roasting in a grate kiln. The grate kiln is an established, energy-efficient operation for producing indurated iron ore pellets for smelting and is used in over 50 plants globally by Metso alone. Roasted pellets from the grate kiln are leached in a rotating drum, and the vanadium is recovered from solution through traditional ammonium metavanadate (AMV) precipitation. The residue is washed in a heap leach to remove traces of vanadium and sold as a FeTi coproduct. These processes have been demonstrated at pilot scale as shown in Figure 1.



**Figure 1 - AVL's process includes reverse flotation, pelletisation, salt-roasting and leaching; demonstrated at full pilot-scale from left-right**

The patent application also covers a nano-filtration and solvent extraction stage for producing an ultra-high purity vanadium as a value-added product. The feed for this operation is the wash solution generated in the previous step. The nanofiltration stage upgrades the vanadium content of the solution, solvent extraction removes impurities. The  $V_2O_5$  product from this process will have a purity of >99.9%.

Work previously announced by the Company during the course of its feasibility studies forms part of the innovative aspects of the patent application, including the following announcements:

- 16<sup>th</sup> March 2020 'Pilot Study Programme Confirms High Vanadium Recoveries and Concentrate Quality'

- 1<sup>st</sup> July 2020 'Pellet Roast Pilot Testing Delivers Uplift in Vanadium Extraction'
- 20<sup>th</sup> August 2020 'Iron-Titanium Co-Product Sales Opportunities to Differentiate AVL'
- 10<sup>th</sup> March 2021 'Final Pyrometallurgy Results Confirm World Leading Vanadium Extraction'
- 8<sup>th</sup> June 2021 'High Vanadium Extractions Confirmed in Pellet Leach Pilot as BFS Progresses'
- 28<sup>th</sup> July 2021 'Vanadium Water Leach Meets Target for World Leading Extraction'
- 13<sup>th</sup> December 2021 'High Purity 99.5% V<sub>2</sub>O<sub>5</sub> Produced in Final Phase of Metallurgical Work for BFS'
- 6<sup>th</sup> April 2022 'Bankable Feasibility Study for the Australian Vanadium Project'

For further information, please contact:

**Vincent Algar, Managing Director**

+61 8 9321 5594

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*This announcement has been produced in accordance with the Company's published continuous disclosure policy and has been approved by the Board.*

## ABOUT AUSTRALIAN VANADIUM LTD

AVL is a resource company focused on vanadium, seeking to offer investors a unique exposure to all aspects of the vanadium value chain – from resource through to steel and energy storage opportunities. AVL is advancing the development of its world-class Australian Vanadium Project at Gabanintha. The Australian Vanadium Project is one of the most advanced vanadium projects being developed globally, with 239Mt at 0.73% vanadium pentoxide ( $V_2O_5$ ), containing a high-grade zone of 95.6Mt at 1.07%  $V_2O_5$  and an Ore Reserve of 30.9Mt at 1.09%  $V_2O_5$  comprised of a Proved Reserve of 5Mt at 1.11%  $V_2O_5$  and a Probable Reserve of 20.4Mt at 1.07%  $V_2O_5$ , reported in compliance with the JORC Code 2012 (see ASX announcement dated 1<sup>st</sup> November 2021 '*Mineral Resource Update at the Australian Vanadium Project*' and ASX announcement dated 6<sup>th</sup> April 2022 '*Bankable Feasibility Study for the Australian Vanadium Project*').

VSUN Energy is AVL's 100% owned subsidiary which is focused on developing the market for vanadium redox flow batteries for energy storage. The companies are also working together to produce and supply vanadium electrolyte for the batteries.

The Company confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and, in the case of estimates of Mineral Resources or Ore Reserves, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The Company confirms that the form and context in which the Competent Person's findings are presented have not been materially modified from the original market announcement.

## APPENDIX 1

The Australian Vanadium Project – Mineral Resource estimate by domain and resource classification using a nominal 0.4% V<sub>2</sub>O<sub>5</sub> wireframed cut-off for low-grade and nominal 0.7% V<sub>2</sub>O<sub>5</sub> wireframed cut-off for high-grade (total numbers may not add up due to rounding).

Zone	Category	Mt	V <sub>2</sub> O <sub>5</sub> %	Fe %	TiO <sub>2</sub> %	SiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	LOI %
HG	Measured	11.3	1.14	43.8	13.0	9.2	7.5	3.7
	Indicated	27.5	1.10	45.4	12.5	8.5	6.5	2.9
	Inferred	56.8	1.04	44.6	11.9	9.4	6.9	3.3
	<b>Subtotal</b>	<b>95.6</b>	<b>1.07</b>	<b>44.7</b>	<b>12.2</b>	<b>9.1</b>	<b>6.8</b>	<b>3.2</b>
LG	Indicated	54.9	0.50	24.9	6.8	27.6	17.1	7.9
	Inferred	73.6	0.48	25.0	6.4	28.7	15.4	6.6
	<b>Subtotal</b>	<b>128.5</b>	<b>0.49</b>	<b>24.9</b>	<b>6.6</b>	<b>28.2</b>	<b>16.1</b>	<b>7.2</b>
Transported	Inferred	14.9	0.66	29.0	7.8	24.5	15.1	7.8
	<b>Subtotal</b>	<b>14.9</b>	<b>0.66</b>	<b>29.0</b>	<b>7.8</b>	<b>24.5</b>	<b>15.1</b>	<b>7.8</b>
Total	Measured	11.3	1.14	43.8	13.0	9.2	7.5	3.7
	Indicated	82.4	0.70	31.7	8.7	21.2	13.5	6.2
	Inferred	145.3	0.71	33.0	8.7	20.7	12.0	5.4
	<b>Subtotal</b>	<b>239.0</b>	<b>0.73</b>	<b>33.1</b>	<b>8.9</b>	<b>20.4</b>	<b>12.3</b>	<b>5.6</b>

The Australian Vanadium Project - Ore Reserve Statement as at April 2022, at a cut-off grade of 0.7% V<sub>2</sub>O<sub>5</sub>.

Ore Reserve	Mt	V <sub>2</sub> O <sub>5</sub> %	Fe%	TiO <sub>2</sub> %	SiO <sub>2</sub> %	LOI%	V <sub>2</sub> O <sub>5</sub> production kt	Ore Reserve	Mt
Proved	10.5	1.11	61.6	12.8	9.5	3.7	70.9	Waste	238.5
Probable	20.4	1.07	63.4	12.2	9.2	3.0	152.9	Total Material	269.4
<b>Total Ore</b>	<b>30.9</b>	<b>1.09</b>	<b>62.8</b>	<b>12.4</b>	<b>9.3</b>	<b>3.2</b>	<b>223.8</b>	Strip Ratio	7.7

### COMPETENT PERSON STATEMENT – EXPLORATION RESULTS AND TARGETS

The information in this announcement that relates to Exploration Results and Exploration Targets is based on and fairly represents information and supporting documentation prepared by Mr Brian Davis (Consultant with Geologica Pty Ltd) and Ms Gemma Lee who is employed by Australian Vanadium Ltd as Principal Geologist. Mr Davis is a member of the Australasian Institute of Mining and Metallurgy and Ms Lee is a member of the Australian Institute of Geoscientists. Both Mr Davis and Ms Lee have sufficient experience of relevance to the styles of mineralisation and types of deposits under consideration, and to the activities undertaken, to qualify as Competent Persons as defined in the 2012 Edition of the Joint Ore Reserves Committee (JORC) Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Specifically, Mr Davis and Ms Lee consent to the inclusion in this announcement of the matters based on their information in the form and context in which they appear.

### **COMPETENT PERSON STATEMENT — MINERAL RESOURCE ESTIMATION**

The information in this announcement that relates to Mineral Resources is based on and fairly represents information compiled by Mr Lauritz Barnes, (Consultant with Trepanier Pty Ltd) and Mr Brian Davis (Consultant with Geologica Pty Ltd). Mr Barnes and Mr Davis are both members of the Australasian Institute of Mining and Metallurgy (AusIMM) and the Australian Institute of Geoscientists (AIG). Both have sufficient experience of relevance to the styles of mineralisation and types of deposits under consideration, and to the activities undertaken to qualify as Competent Persons as defined in the 2012 Edition of the Joint Ore Reserves Committee (JORC) Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Specifically, Mr Barnes is the Competent Person for the estimation and Mr Davis is the Competent Person for the database, geological model and site visits. Mr Barnes and Mr Davis consent to the inclusion in this announcement of the matters based on their information in the form and context in which they appear.

### **COMPETENT PERSON STATEMENT — METALLURGICAL RESULTS**

The information in this announcement that relates to Metallurgical Results is based on information compiled by independent consulting metallurgist Brian McNab (CP. B.Sc Extractive Metallurgy). Mr McNab is a Member of AusIMM. He is employed by Wood Australia Pty Ltd. Mr McNab has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which is undertaken, to qualify as a Competent Person as defined in the JORC 2012 Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Mr McNab consents to the inclusion in the announcement of the matters based on the information made available to him, in the form and context in which it appears.

### **COMPETENT PERSON STATEMENT — ORE RESERVES**

The technical information in this announcement that relates to the Ore Reserve estimate for the Project is based on information compiled by Mr Ross Cheyne, an independent consultant to AVL. Mr Cheyne is a Fellow of the Australasian Institute of Mining and Metallurgy. He is an employee and Principal Consultant of Orelogy Consulting Pty Ltd. Mr Cheyne has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a competent person as defined in the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Mr Cheyne consents to the inclusion in the announcement of the matters related to the Ore Reserve estimate in the form and context in which it appears.

## FORWARD LOOKING STATEMENTS

This release may contain certain forward-looking statements with respect to matters including but not limited to the financial condition, results of operations and business of AVL and certain of the plans and objectives of AVL with respect to these items.

These forward-looking statements are not historical facts but rather are based on AVL's current expectations, estimates and projections about the industry in which AVL operates and its beliefs and assumptions.

Words such as "anticipates," "considers," "expects," "intends," "plans," "believes," "seeks," "estimates", "guidance" and similar expressions are intended to identify forward looking statements and should be considered an at-risk statement. Such statements are subject to certain risks and uncertainties, particularly those risks or uncertainties inherent in the industry in which AVL operates.

These statements are not guarantees of future performance and are subject to known and unknown risks, uncertainties, and other factors, some of which are beyond the control of AVL, are difficult to predict and could cause actual results to differ materially from those expressed or forecasted in the forward-looking statements. Such risks include, but are not limited to resource risk, metal price volatility, currency fluctuations, increased production costs and variances in ore grade or recovery rates from those assumed in mining plans, as well as political and operational risks in the countries and states in which we sell our product to, and government regulation and judicial outcomes. For more detailed discussion of such risks and other factors, see the Company's Annual Reports, as well as the Company's other filings.

AVL cautions shareholders and prospective shareholders not to place undue reliance on these forward-looking statements, which reflect the view of AVL only as of the date of this release.

The forward-looking statements made in this announcement relate only to events as of the date on which the statements are made.

AVL will not undertake any obligation to release publicly any revisions or updates to these forward-looking statements to reflect events, circumstances or unanticipated events occurring after the date of this announcement except as required by law or by any appropriate regulatory authority.