Tuomo Karinen (Geological Survey of Finland), 11 October 2022

Commodity	**Vanadium (V)**	**Data source**
Significance for the EU (2023)	*Critical, not strategic*	
Uses of the commodity	Main uses: *High-strength low-alloy (HSLA) steel, special steels* Minor uses: *Vanadium redox flow batteries in clean energy transition, super alloys, chemicals, catalyst, glass* Future uses: *New alloys. Forecasted strong growth for vanadium redox-flow batteries*	BRGM et al. (2017), Hund et al. (2020), USGS (2022)
Resources and potential in Nordic countries	Finland: *Known resources 1.19 Mt V (2.19 Mt if V in mica in Talvivaara black schist is included). Mustavaara deposit: 103.7 Mt @ 0.138 % V, 0.56 % Ti and 9.7 % Fe; Koitelainen intrusion V unit: 116.4 Mt @ 0.063 % V; Otanmäki deposit: 14 Mt @ 40 % Fe, 7.6 % Ti, 0.26 % V. Undiscovered resources at regional scale estimated to 13 Mt V.* Greenland: *Known resources 179,000 t V. Isortoq N dyke 70.3 Mt @ 0.081 % V, 6.53 % Ti, 26.9 % Fe, Skaergaard intrusion 104 Mt @ 0.12 % V, 4.68 % Ti.* Norway: *Known resources 0.32 Mt V. Lauvneset intrusion: 313 Mt @ 0.44 % V, 3.54 % Ti, 4 % P_2O_5; Selvåg intrusion: 44 Mt @ 0.15 % V, 2.5 % Ti, Raudsand: 11 Mt @ 0.5 % V* Sweden: *Known resources 4.42 Mt V. Häggån shale: 2005 Mt @ 0.169 % V, 0.021 % Mo, 0.033 % Ni; Routivare malmfält intrusion: 140 Mt @ 0.2 % V, 5.7 % Ti. Hörby shale: 116.8 Mt @ 0.219 % V.*	Eilu et al. (2021, 2022), Karinen et al. (2022), Rosa et al. (2023)
Anthropogenic resources and potential in Nordic countries	*Steel-plant slag, steel scrap, fly ash, used catalysts.*	Neometals (2022)
Main deposit types in Nordic countries	*Magnetite-rich layers in 2.50–2.44 Ga layered mafic-ultramafic intrusions, V-Ti-Fe ± apatite ore bodies in Palaeo- and Neoproterozoic mafic intrusions, Caledonide shales in Sweden, and in Palaeoproterozoic black schists in Finland. Possible potential in heavy-mineral sands in Greenland and Iceland.*	Eilu et al. (2021, 2022)
Main global deposit types	*Magnetite-rich layers in layered mafic-ultramafic intrusions and V-Ti-Fe ± apatite ore bodies in mafic intrusions are the current main*	Brough et al. (2019), Rappleye & Haun

	source of virgin V (88 %). Black shale, phosphorite, roll-front uranium deposits, bauxite, coal, crude oil contain potentially recoverable V.	(2021), Simandl & Paradis (2022)
Global production (2022)	*100,000 t V* *Most of vanadium is currently obtained as a byproduct from slags created during iron and steel production.*	Simandl & Paradis (2022), USGS (2023)
Nordic production (2021)	*None*	
Main producing countries (2022)	*China 70 %, Russia 17 %, South Africa 9.1 %, Brazil 6.2 %*	USGS (2023)
Technological challenges in production	*Typically recovered as a byproduct or a coproduct. Hence, recovery of the main commodity of an ore mostly has a priority and V recovery not necessarily given much effort.*	BRGM et al. (2017), USGS (2022)
Recycling	Present: *Scrap and slag recycling is relatively easy, whereas recovery from fly ash, catalysts, and chemicals significantly more expensive. Slightly less than 50 % of V is recycled. On the other hand, EoL-RIR of vanadium in the EU for 2012–2016 was only 2 %.* Future: *In addition to the current sources, recovery from steel slag, fly ash, catalysts, and municipal wastes will increase.*	Painuly (2015), BRGM et al. (2017), Dong et al. (2019), Latunussa et al. (2020)

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