



Mineraliseringen med sällsynta jordartsmetaller (REE) i Olserum-Djupedal, Småland – en del av pusslet för att förstå hur större REE-förekomster bildas

Stefan Andersson



FoU seminarium 2020

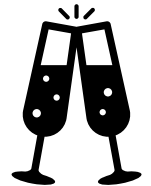




Tack till



Geologiska Föreningen



Thomas Wagner (RWTH Aachen)
Erik Jonsson (SGU/UU)
Karin Högdahl (UU)

Sällsynta jordartsmetaller

Rare earth elements = REE

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|--|--|--|---|---|---|---|---|--|--|--|---|---|--|---|--|---|--------------------------------------|--|---|--|---------------------------------------|--|---|---------------------------------------|--|---------------------------------------|--------------------------------------|---------------------------------------|---|--|--|---------------------------------------|--|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--|--|---|---|
| 1 IA 1A | | | | | | | | | | | | | | | | | 18 VIIIA 8A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 H Hydrogen 1.008 | | | | | | | | | | | | | | | | | 2 He Helium 4.003 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 Li Lithium 6.941 | 4 Be Beryllium 9.012 | | | | | | | | | | | 5 B Boron 10.811 | 6 C Carbon 12.011 | 7 N Nitrogen 14.007 | 8 O Oxygen 15.999 | 9 F Fluorine 18.998 | 10 Ne Neon 20.180 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 Na Sodium 22.990 | 12 Mg Magnesium 24.305 | 3 IIIB 3B | 4 IVB 4B | 5 VB 5B | 6 VIB 6B | 7 VIIB 7B | 8 VIII 8 | 9 VIII 8 | 10 VIII 8 | 11 IB 1B | 12 IIB 2B | 13 Al Aluminium 26.982 | 14 Si Silicon 28.086 | 15 P Phosphorus 30.974 | 16 S Sulfur 32.066 | 17 Cl Chlorine 35.453 | 18 Ar Argon 39.948 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 K Potassium 39.098 | 20 Ca Calcium 40.078 | 21 Sc Scandium 44.956 | 22 Ti Titanium 47.867 | 23 V Vanadium 50.942 | 24 Cr Chromium 51.996 | 25 Mn Manganese 54.938 | 26 Fe Iron 55.845 | 27 Co Cobalt 58.933 | 28 Ni Nickel 58.693 | 29 Cu Copper 63.546 | 30 Zn Zinc 65.38 | 31 Ga Gallium 69.723 | 32 Ge Germanium 72.631 | 33 As Arsenic 74.922 | 34 Se Selenium 78.971 | 35 Br Bromine 79.904 | 36 Kr Krypton 83.798 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 Rb Rubidium 85.468 | 38 Sr Strontium 87.62 | 39 Y Yttrium 88.906 | 40 Zr Zirconium 91.224 | 41 Nb Niobium 92.906 | 42 Mo Molybdenum 95.95 | 43 Tc Technetium 98.907 | 44 Ru Ruthenium 101.07 | 45 Rh Rhodium 102.906 | 46 Pd Palladium 106.42 | 47 Ag Silver 107.868 | 48 Cd Cadmium 112.414 | 49 In Indium 114.818 | 50 Sn Tin 118.711 | 51 Sb Antimony 121.760 | 52 Te Tellurium 127.6 | 53 I Iodine 126.904 | 54 Xe Xenon 131.294 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 Cs Cesium 132.905 | 56 Ba Barium 137.328 | 57-71 | 72 Hf Hafnium 178.49 | 73 Ta Tantalum 180.948 | 74 W Tungsten 183.84 | 75 Re Rhenium 186.207 | 76 Os Osmium 190.23 | 77 Ir Iridium 192.217 | 78 Pt Platinum 195.085 | 79 Au Gold 196.967 | 80 Hg Mercury 200.592 | 81 Tl Thallium 204.383 | 82 Pb Lead 207.2 | 83 Bi Bismuth 208.980 | 84 Po Polonium (209) | 85 At Astatine (209) | 86 Rn Radon (222) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87 Fr Francium 223.020 | 88 Ra Radium 226.025 | 89-103 | 104 Rf Rutherfordium (261) | 105 Db Dubnium (262) | 106 Sg Seaborgium (266) | 107 Bh Bohrium (264) | 108 Hs Hassium (265) | 109 Mt Meitnerium (278) | 110 Ds Darmstadtium (281) | 111 Rg Roentgenium (280) | 112 Cn Copernicium (285) | 113 Nh Nihonium (286) | 114 Fl Flerovium (289) | 115 Mc Moscovium (289) | 116 Lv Livermorium (293) | 117 Ts Tennessine (294) | 118 Og Oganesson (294) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <tr> <td>57 La Lanthanum 138.905</td> <td>58 Ce Cerium 140.116</td> <td>59 Pr Praseodymium 140.908</td> <td>60 Nd Neodymium 144.243</td> <td>61 Pm Promethium 144.913</td> <td>62 Sm Samarium 150.36</td> <td>63 Eu Europium 151.964</td> <td>64 Gd Gadolinium 157.25</td> <td>65 Tb Terbium 158.925</td> <td>66 Dy Dysprosium 162.500</td> <td>67 Ho Holmium 164.930</td> <td>68 Er Erbium 167.259</td> <td>69 Tm Thulium 168.934</td> <td>70 Yb Ytterbium 173.055</td> <td>71 Lu Lutetium 174.967</td> </tr> <tr> <td>89 Ac Actinium 227.028</td> <td>90 Th Thorium 232.038</td> <td>91 Pa Protactinium 231</td> <td>92 U Uranium 238.029</td> <td>93 Np Neptunium 237.048</td> <td>94 Pu Plutonium 244.064</td> <td>95 Am Americium 243.061</td> <td>96 Cm Curium 247.070</td> <td>97 Bk Berkelium 247.070</td> <td>98 Cf Californium 251.080</td> <td>99 Es Einsteinium (254)</td> <td>100 Fm Fermium 257.085</td> <td>101 Md Mendelevium 258.1</td> <td>102 No Nobelium 259.101</td> <td>103 Lr Lawrencium (262)</td> </tr> </table> | | | | | | | | | | | | | | | | | | 57 La Lanthanum 138.905 | 58 Ce Cerium 140.116 | 59 Pr Praseodymium 140.908 | 60 Nd Neodymium 144.243 | 61 Pm Promethium 144.913 | 62 Sm Samarium 150.36 | 63 Eu Europium 151.964 | 64 Gd Gadolinium 157.25 | 65 Tb Terbium 158.925 | 66 Dy Dysprosium 162.500 | 67 Ho Holmium 164.930 | 68 Er Erbium 167.259 | 69 Tm Thulium 168.934 | 70 Yb Ytterbium 173.055 | 71 Lu Lutetium 174.967 | 89 Ac Actinium 227.028 | 90 Th Thorium 232.038 | 91 Pa Protactinium 231 | 92 U Uranium 238.029 | 93 Np Neptunium 237.048 | 94 Pu Plutonium 244.064 | 95 Am Americium 243.061 | 96 Cm Curium 247.070 | 97 Bk Berkelium 247.070 | 98 Cf Californium 251.080 | 99 Es Einsteinium (254) | 100 Fm Fermium 257.085 | 101 Md Mendelevium 258.1 | 102 No Nobelium 259.101 | 103 Lr Lawrencium (262) |
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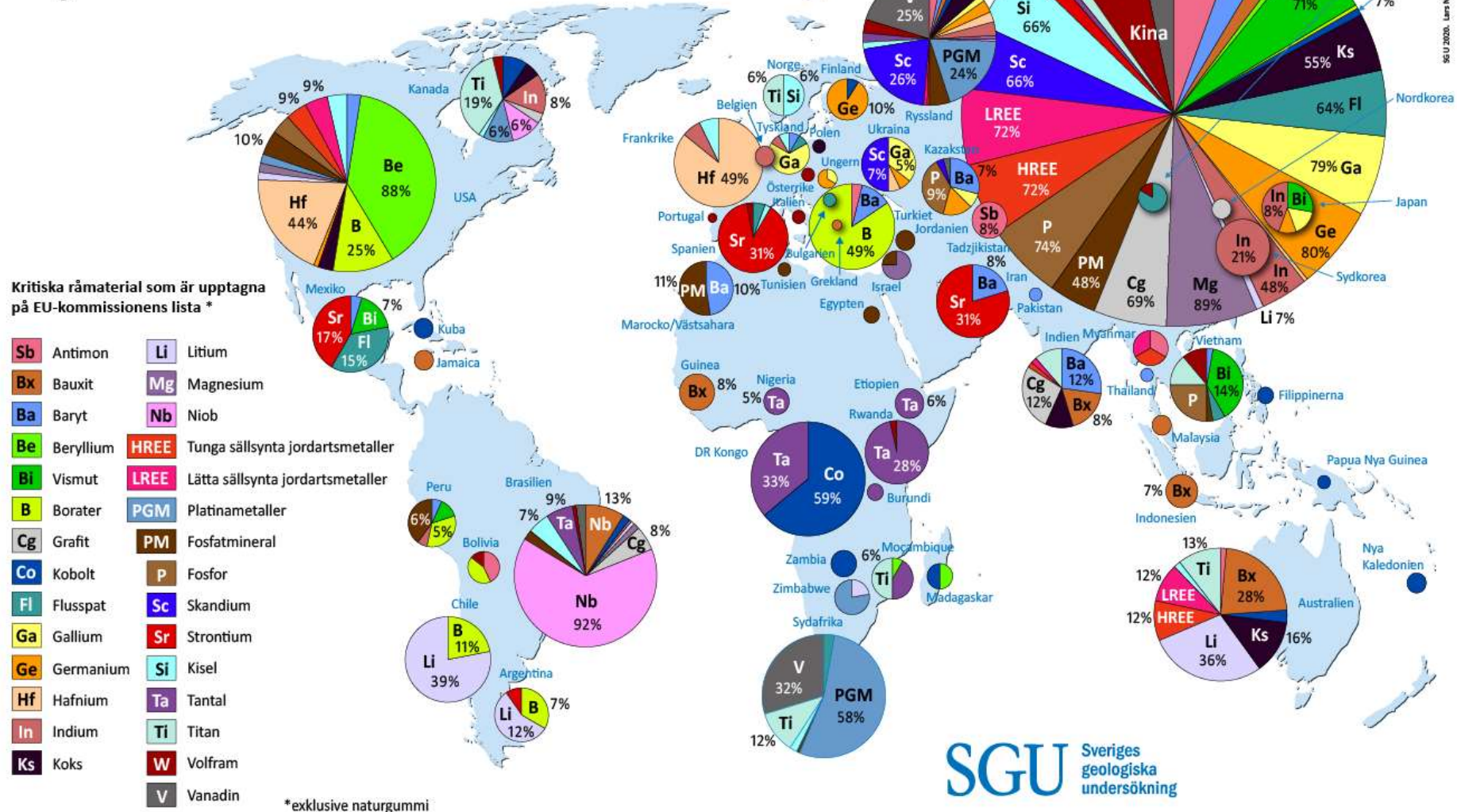
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Sällsynta jordartsmetaller

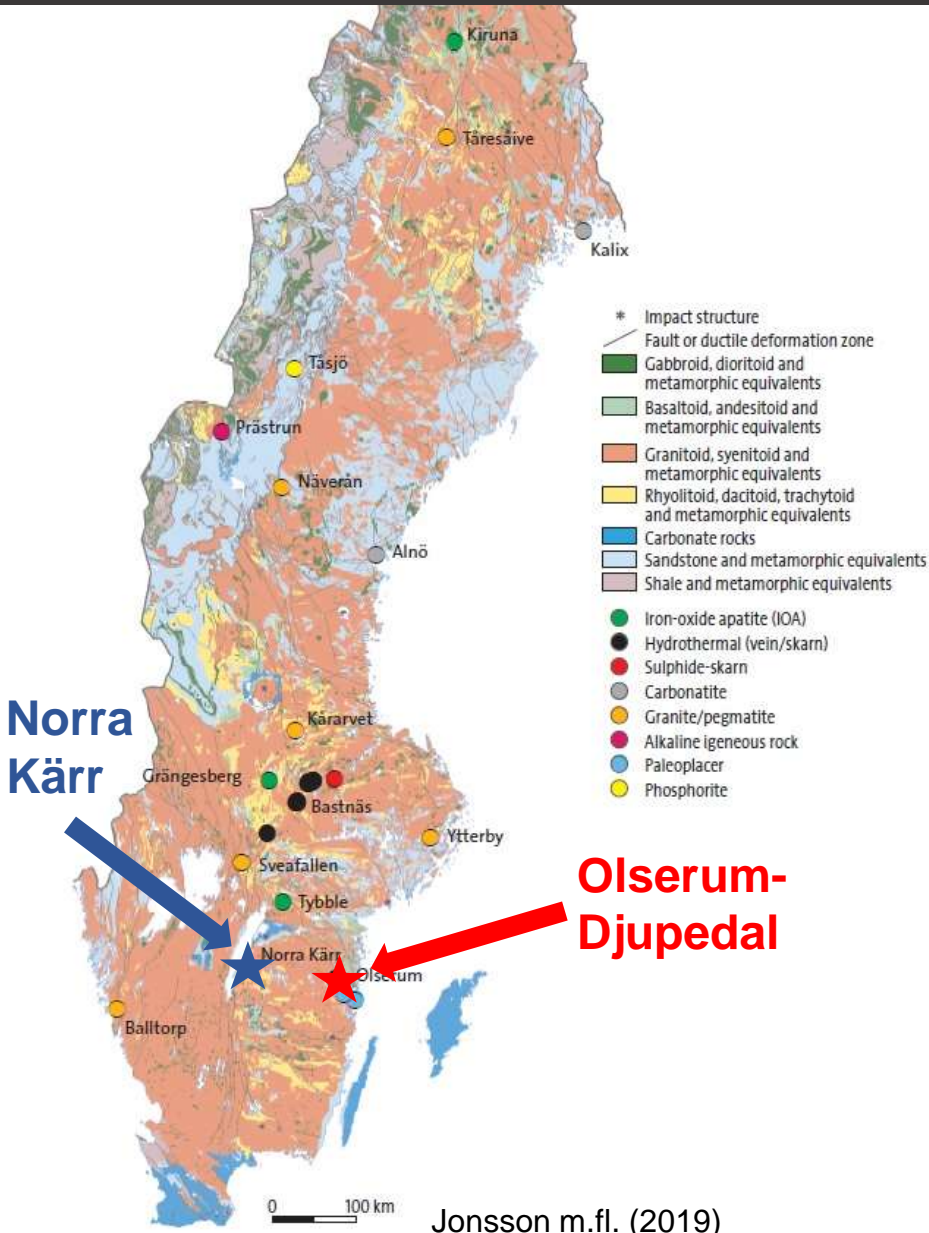
Global produktion av kritiska råmaterial (CRM)

enligt EUs definition



SGU 2020. Lars Martin och Fredrik Karlsson

Sällsynta jordartsmetaller i Sverige



Norra Kärr

En av Europas största förekomster

Stor potential att bli en REE-producerande gruva

Definierad resurs

(internationellt NI-43-101-klassad):

41,6 Mt och **0,57% TREO**

(*total rare earth oxides*)

Olserum-Djupedal

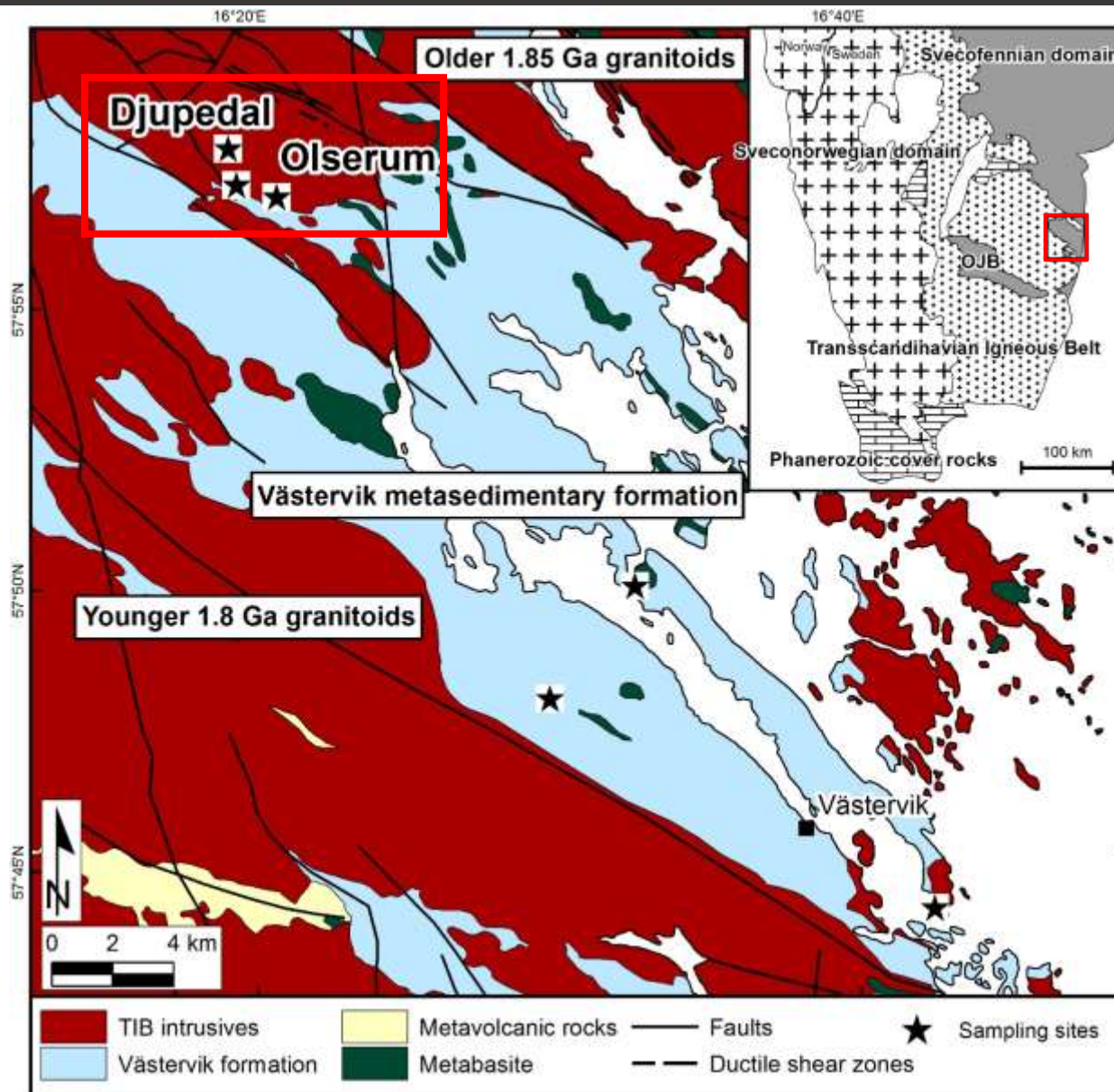
NI-43-101-klassad resurs:

4,5 Mt och **0,6% TREO**

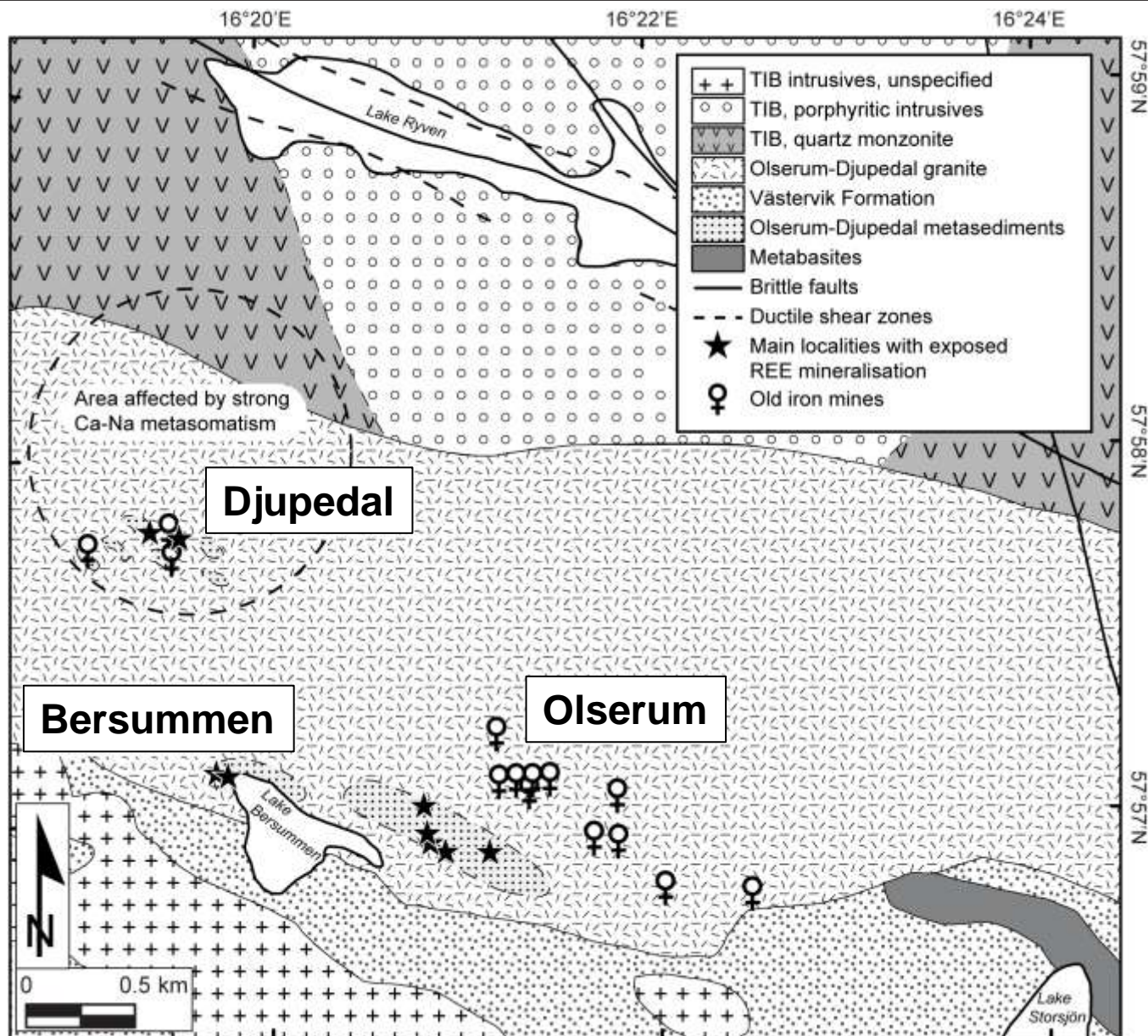
Den definierade resursen täcker bara en del av den kända mineraliseringen

Geografiskt nära men malmgeologiskt helt skilda

REE-mineraliseringen i Olserum-Djupedal



REE-mineraliseringen i Olserum-Djupedal



REE-mineraliseringen i Olserum-Djupedal



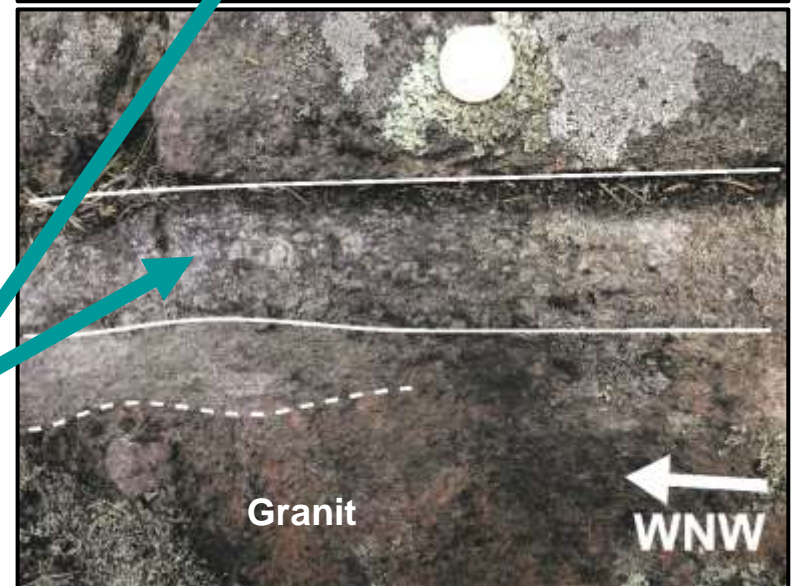
Metasedimentär
värdbergart

Gångar med biotit + kvarts + magnetit ± amfibol ±
fluorapatit ± **xenotim-(Y)** ± **monazit-(Ce)** i
metasedimentära bergarter och granit

| | |
|----------------------------------|--|
| Xenotim-(Y) | $(Y, HREE)PO_4$ |
| Monazit-(Ce) | $(LREE, Y)PO_4$ |
| Fluorapatit | $Ca_5(PO_4)_3F$ |
| Allanit-(Ce) – ferriallanit-(Ce) | $(LREE, Ca, Y)_2(Al, Fe)_3(SiO_4)_3(OH)$ |
| Fergusonit-(Y) | $(Y, HREE)NbO_4$ |
| Samarskit-(Y) | $(Y, HREE, Fe, U)_2(Nb, Ta)_2O_8$ |
| Bastnäsit-(Ce) | $(LREE, Y)CO_3F$ |



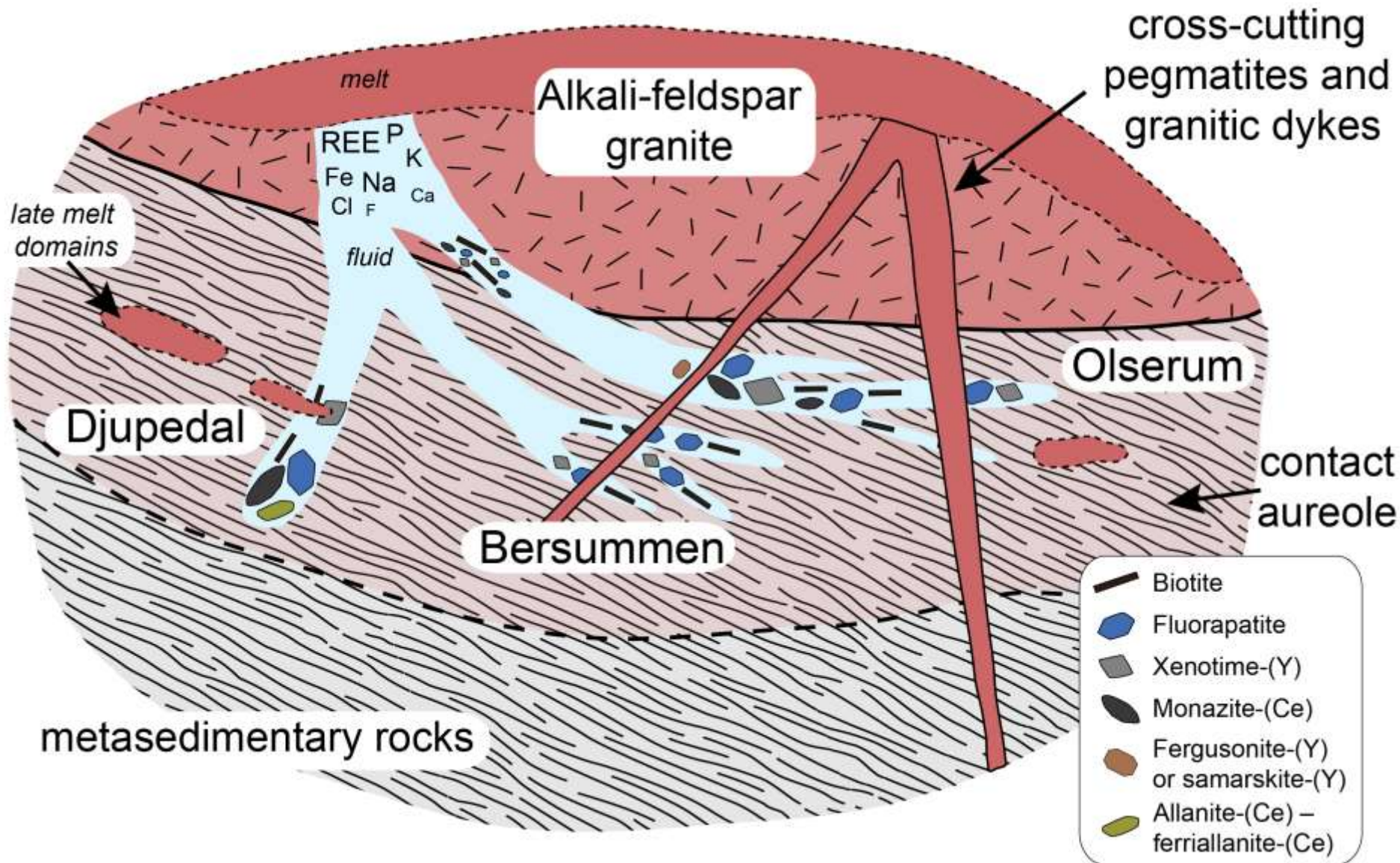
Grovkorniga xenotim-(Y)-
kristaller och aggregat



Granit

WNW

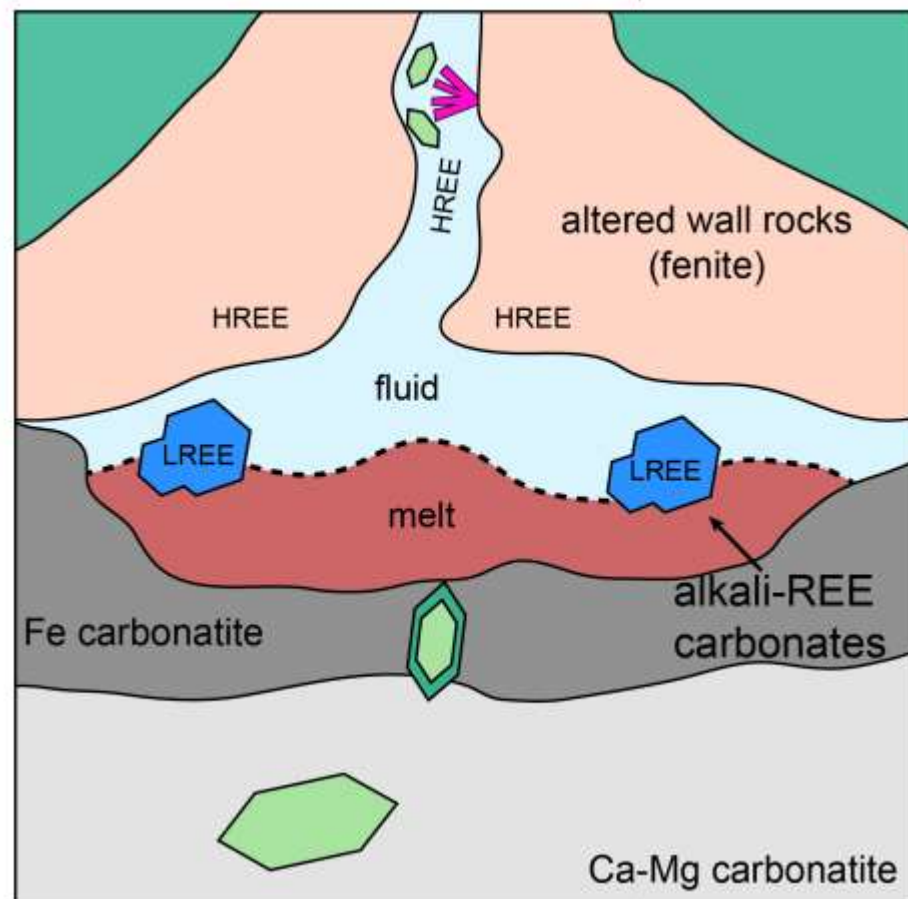
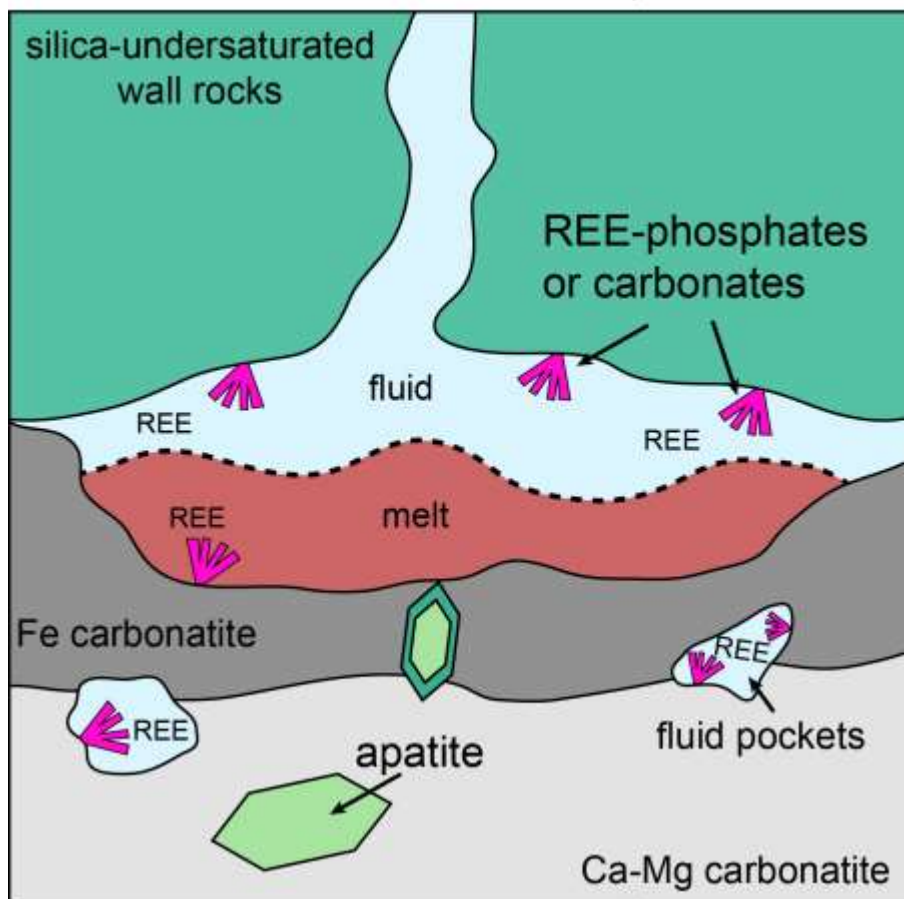
REE-mineraliseringen i Olserum-Djupedal



Karbonatiter och REE-förekomster

REE, Cl⁻, F⁻, CO₃²⁻, PO₄³⁻, Ca²⁺, Fe³⁺, Mg²⁺

+ Na⁺, K⁺



Efter Anenburg m.fl. (2020)

Tack!