

Hyperspektriaineiston tulkinta geoympäristö sovelluksissa

- Maarit Middleton, erikoistutkija
- Geologian tutkimuskeskus,
Ympäristögeologian yksikkö, Rovaniemi
- HYPE TKI loppuseminaari, OAMK
- Oulun yliopisto, 16.4.2019

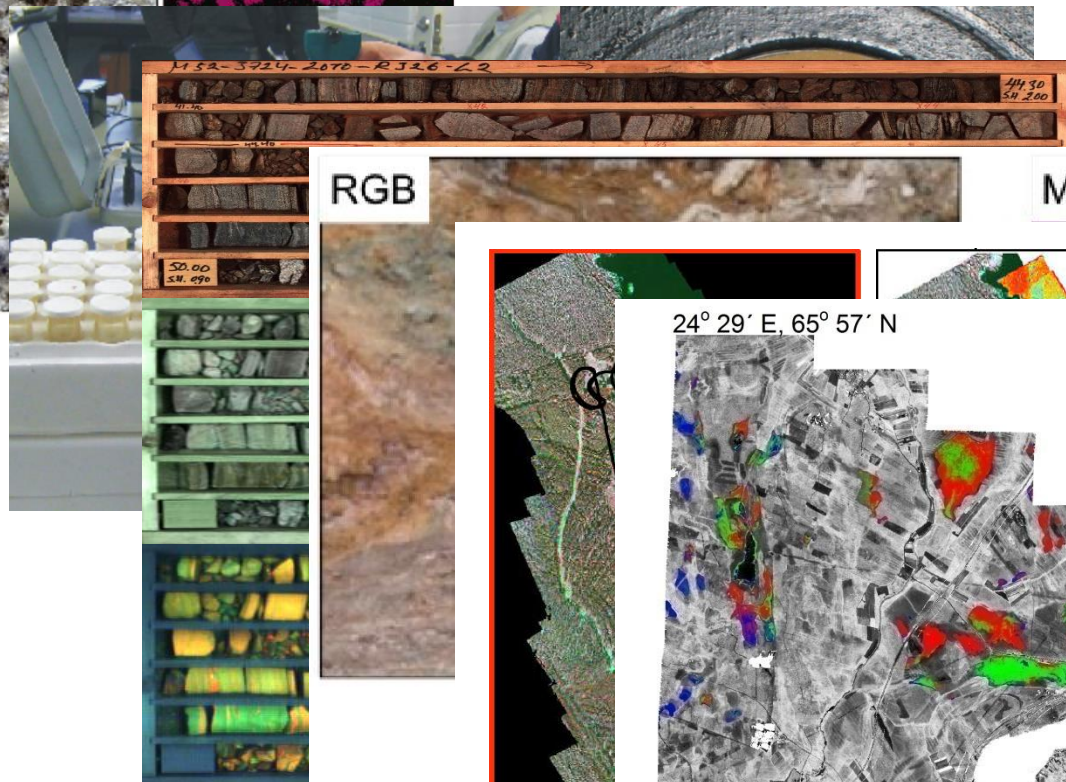


GTK
gtk.fi

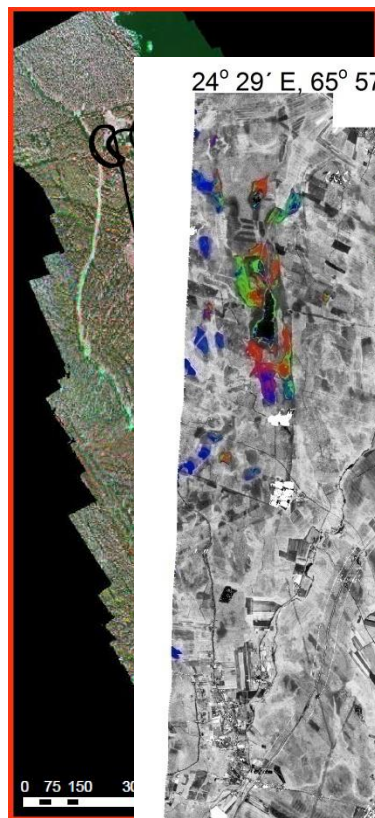
Sample F



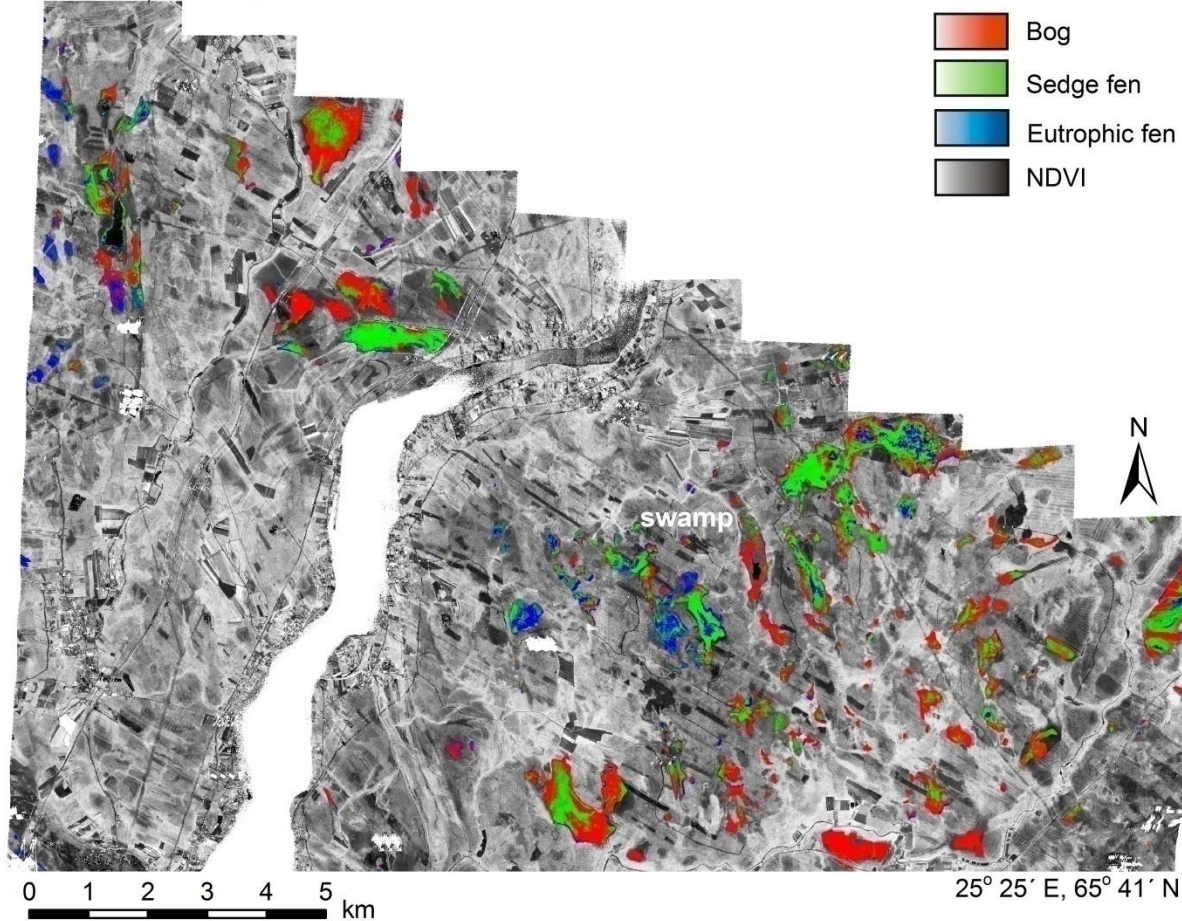
1 cm



10 cm



24° 29' E, 65° 57' N



- Bog
- Sedge fen
- Eutrophic fen
- NDVI


Kairasydänten hyperspektrikuvaus malminetsinnässä


- Hype Tki – Oulun ammattikorkeakoulu
16.04.2019
- Soile Aatos & Hattu 3D -projekti
- Geologian tutkimuskeskus

Vipuvoimaa
EU:lta
2014–2020



BUSINESS
FINLAND

 Endomines

 NURMEKSEN
TYÖSTÖ JA TARVIKE OY

 PALSATECH

FUTURE MISSIONS OY
NON-PROFIT COMPANY

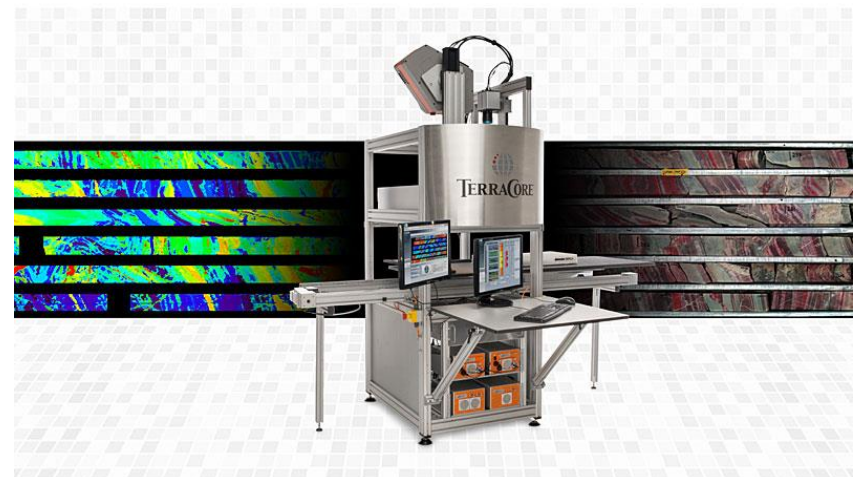
JOSEK 



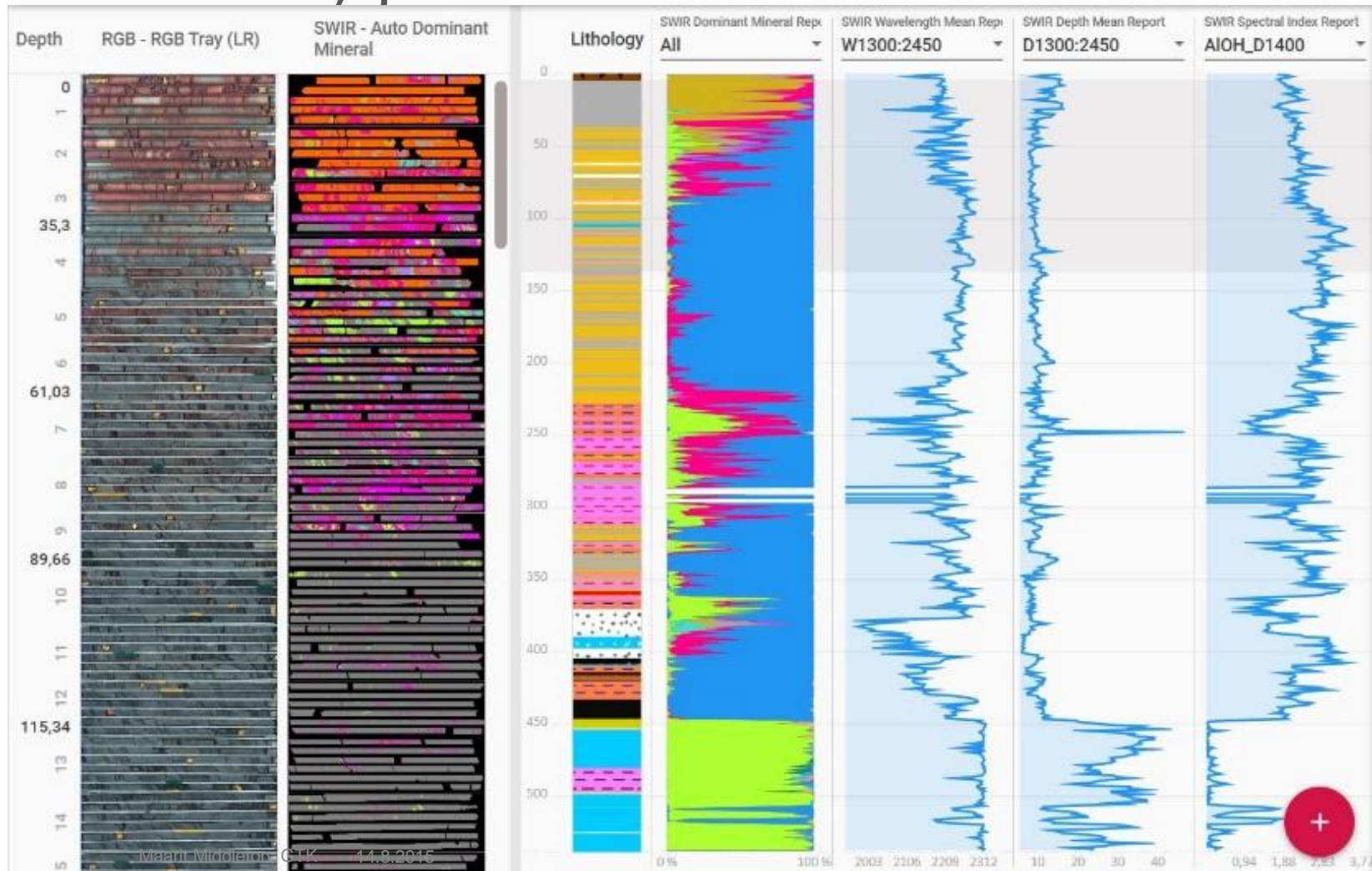
GTK
gtk.fi

Hyperspektrikuvaus malminetsinnässä

- Tavoite:
 - Kallioperäkairaustiedon keruun ja tulkinno-
nopeuttaminen ja kustannustehokkuuden
parantaminen prosessia digitalisoimalla
- Käyttökohde:
 - Kallioperän mineralogian tunnistaminen ja
tulkitseminen
 - Näyteaineistona kallioperän kairaus-
sydämet



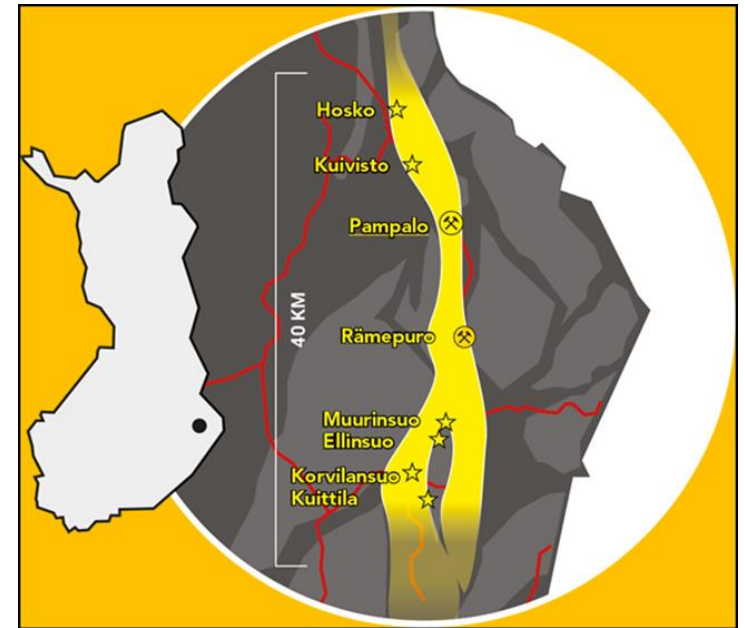
Kairausaineiston hyperspektrikuvausten käsittely ja tulkinta



Kuva: IntelliCore

Hattu 3D –projekti (2018-2019)

- Kohteena kultapotentiaallinen kallioperän Hattu-liuskejakso Ilomantsissa, Pohjois-Karjalassa
- Tavoitteena malmitumiseen liittyvien mineralogisten muuttumisilmiöiden tunnistaminen ja spatiaalinen rajaaminen vanhoista kairausaineistoista
- Kehittää alueen kultamalmeihin liittyvää hyperspektritiedon jatkotulkintaa tekoälymenetelmin
- Hyödyntää mm. skannatun ja pistemäisen spektrimittaustiedon yhteiskäyttöä tulkinnassa
- Projektia rahoittavat Business Finland ja yritykset (EAKR)



Kuva: Endomines AB

Apatiitin ja kalsiitti-dolomiitin tunnistus Kortejärven karbonaatti-intruusion kivistä

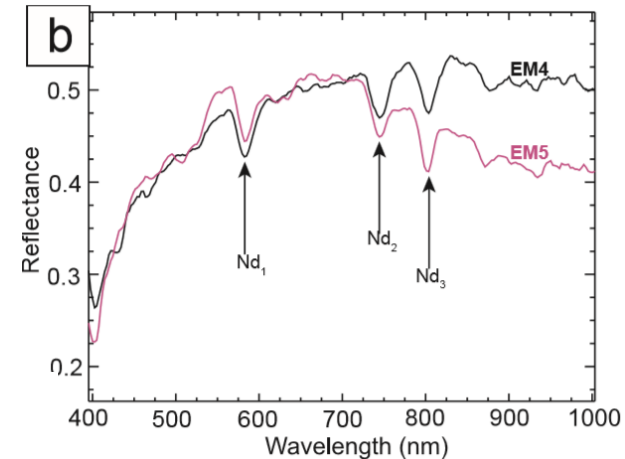
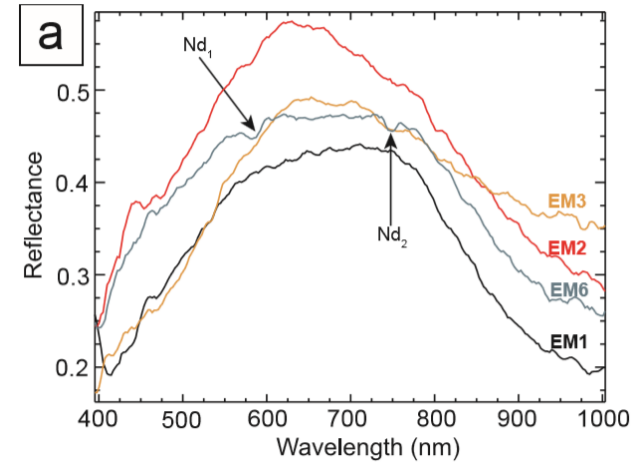
- K. Laakso, M. Middleton, T. Heinig, R. Bärs, P. Lintinen
- *Aalto University, Department of Civil Engineering, Rakentajanaukio 4 A, FI-02150 Espoo, Finland*
- *Geological Survey of Finland, Lähteentie 2, FI-96101 Rovaniemi, Finland*
- *Helmholtz Institute Freiberg for Resource Technology, Chemnitzer Strasse 40, 09599 Freiberg, Germany*
- *Specim, Spectral Imaging Ltd., Elektriikkatie 13, 90590 Oulu, Finland*

Apatiitin tunnistus VNIR spektrialueella

Spatial-Spectral Endmember Extraction (SSEE)

Apatiitti päätejäsenten valinta

Spectral angle mapper (SAM)



Sample C

1 cm

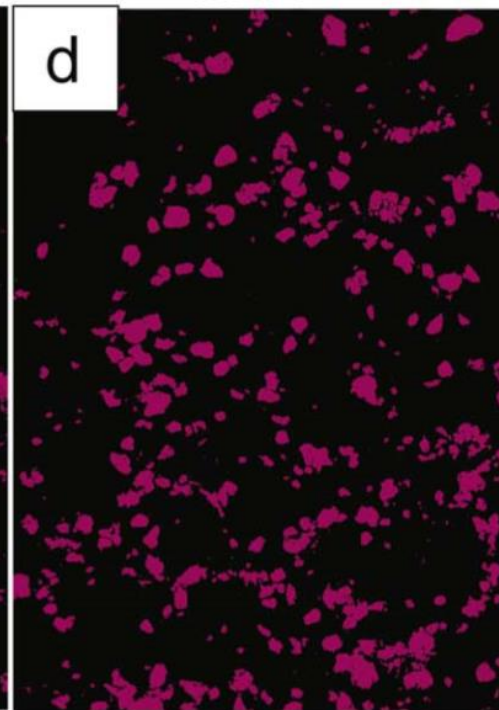
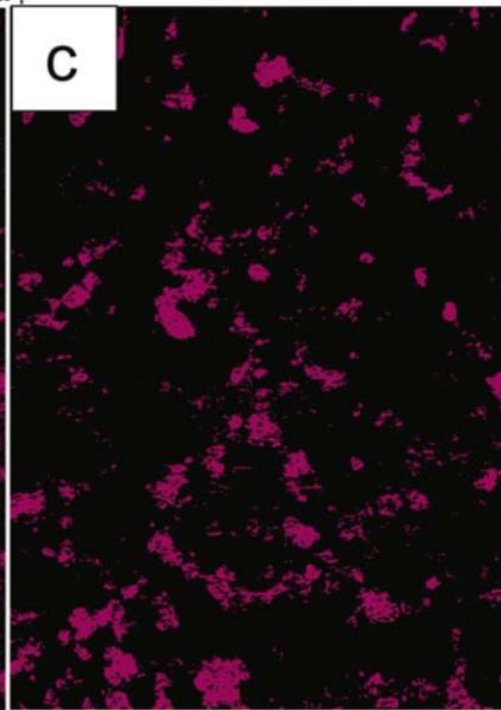
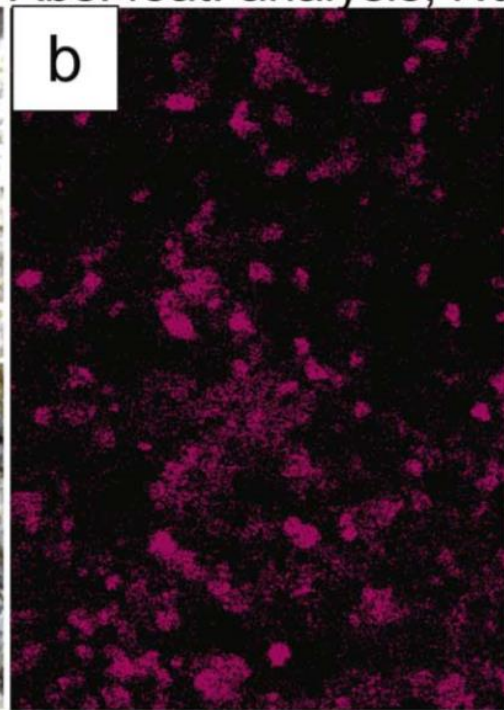
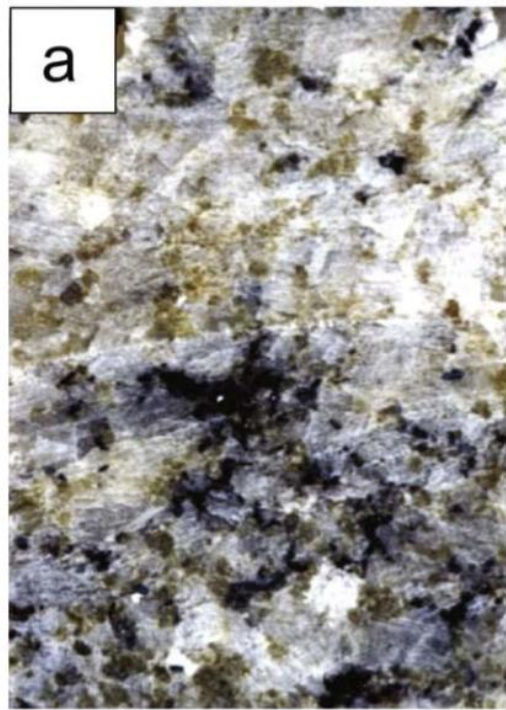
HSI

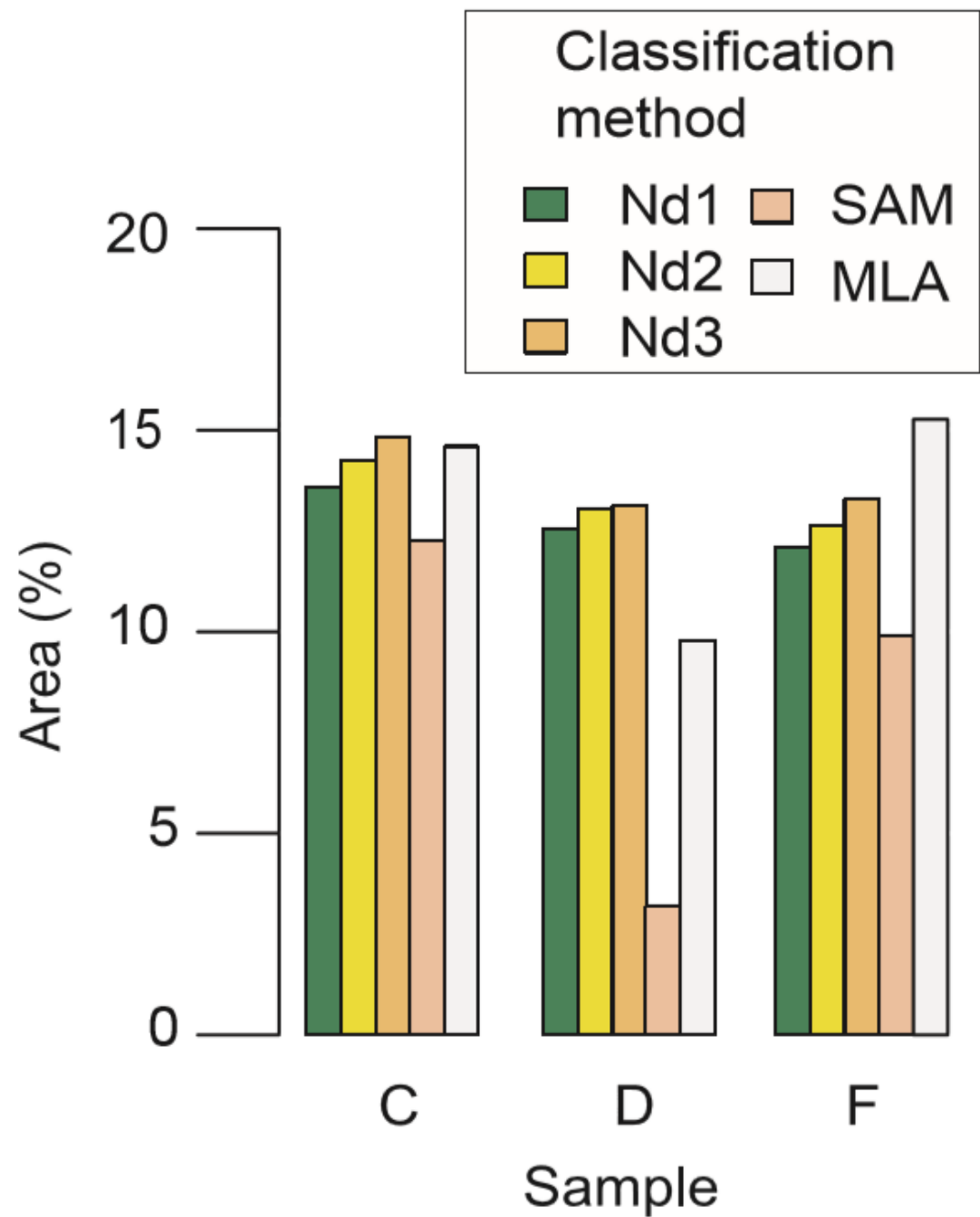
Abs. feat. analysis, Nd₁

Apatite

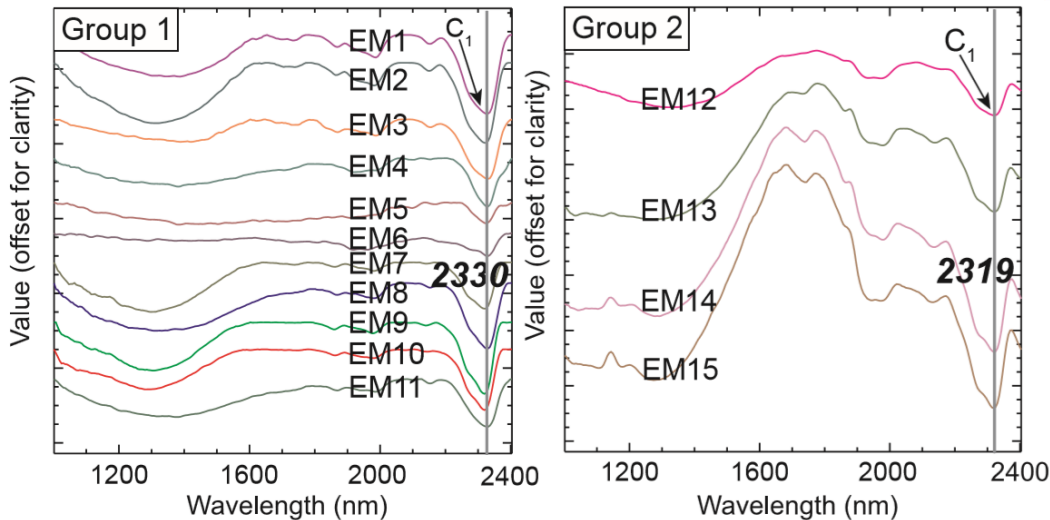
SAM

MLA

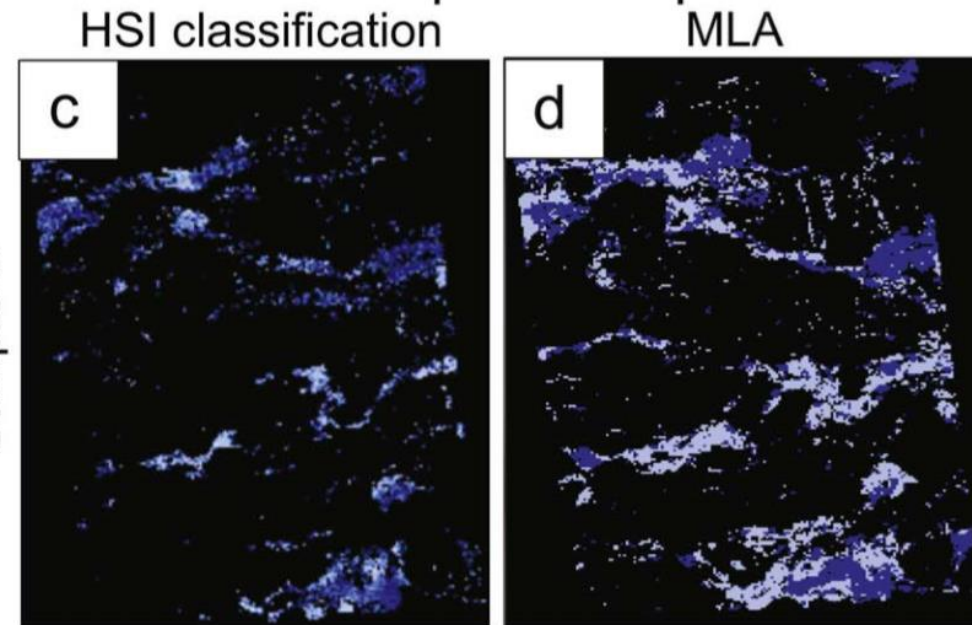




Kalsiitti-dolomiitti absorptiot: 2019 nm ja 2325–2330nm



Sample B





Moreenin hienoaineksen kemiallisen koostumuksen kemometrinen mallinnus

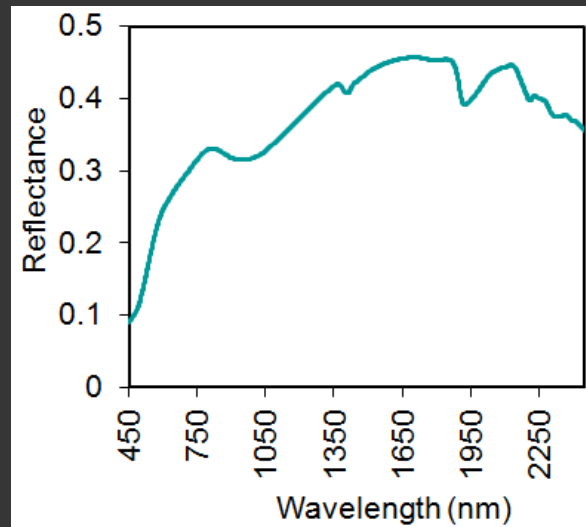
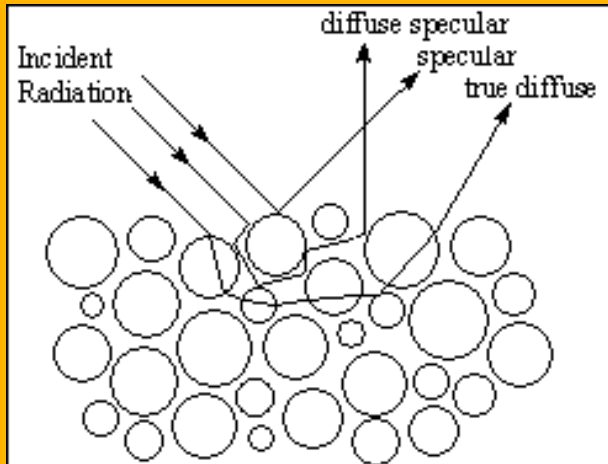
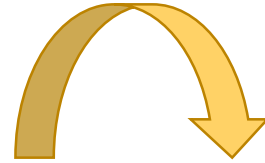
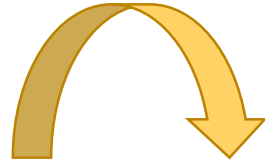
Maarit Middleton¹,

Paavo Närhi¹, Viljo Kuosmanen², Raimo Sutinen¹

¹*Geological Survey of Finland, Rovaniemi*

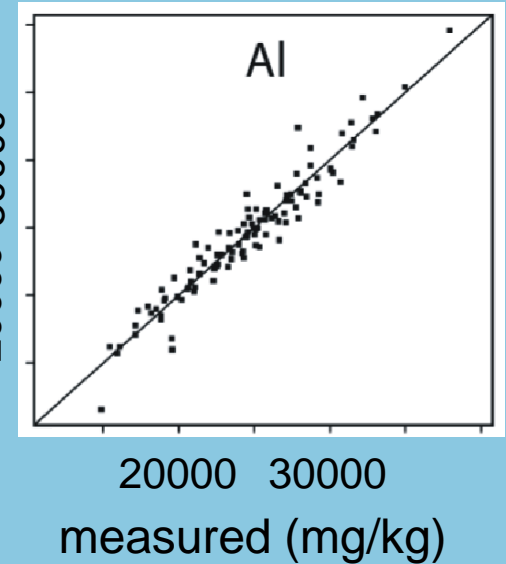
²*Geological Survey of Finland, Espoo*

Reflektanssispektroskopia ja kemometrinen mallinnus

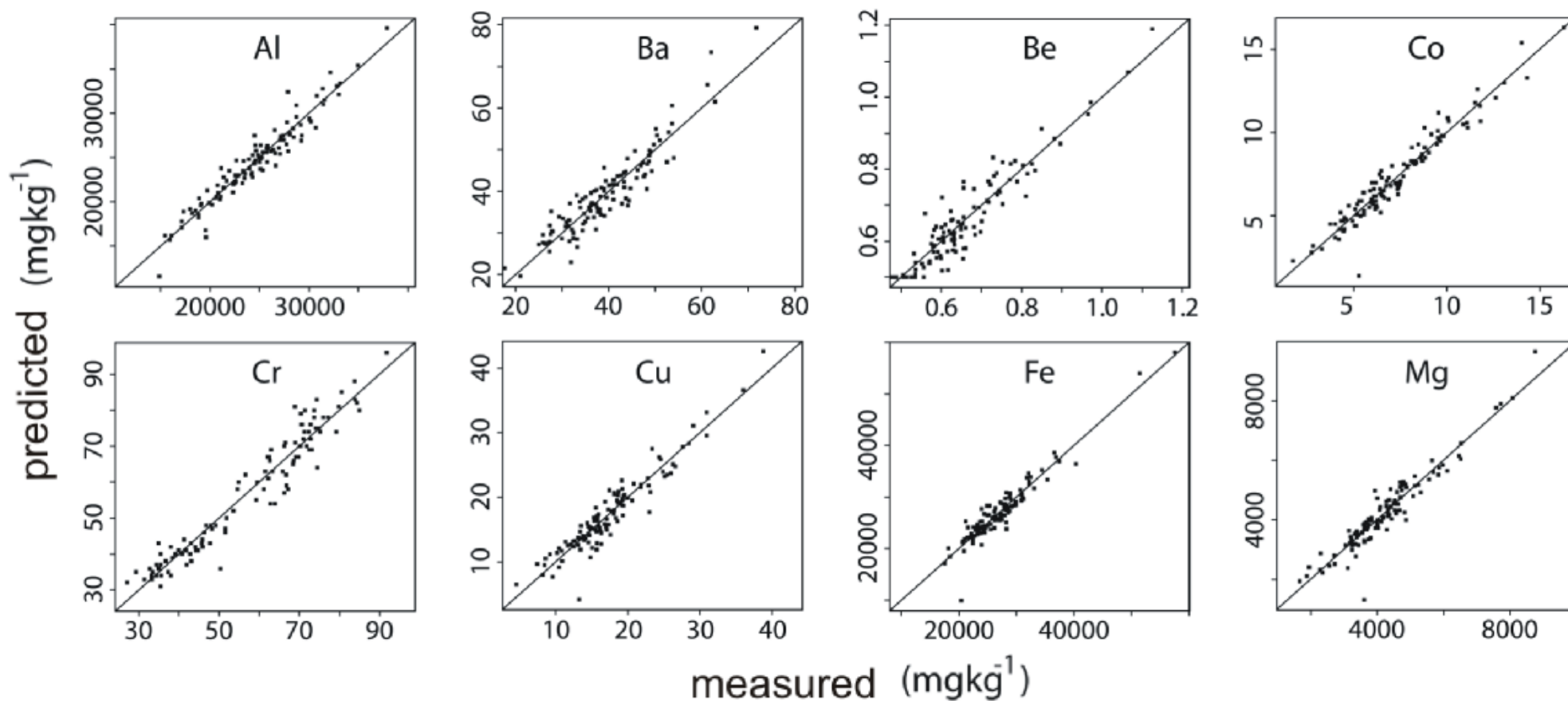


predicted (mg/kg)

20000 30000



Partial least-squares regression tuloksia



n=217, tills 1 and 2 combined
(Middleton et al. 2011)



Aikastabiilien maankosteusluokkien kartoitus hyperspektriaineistosta männyn uudistamisen tarpeisiin

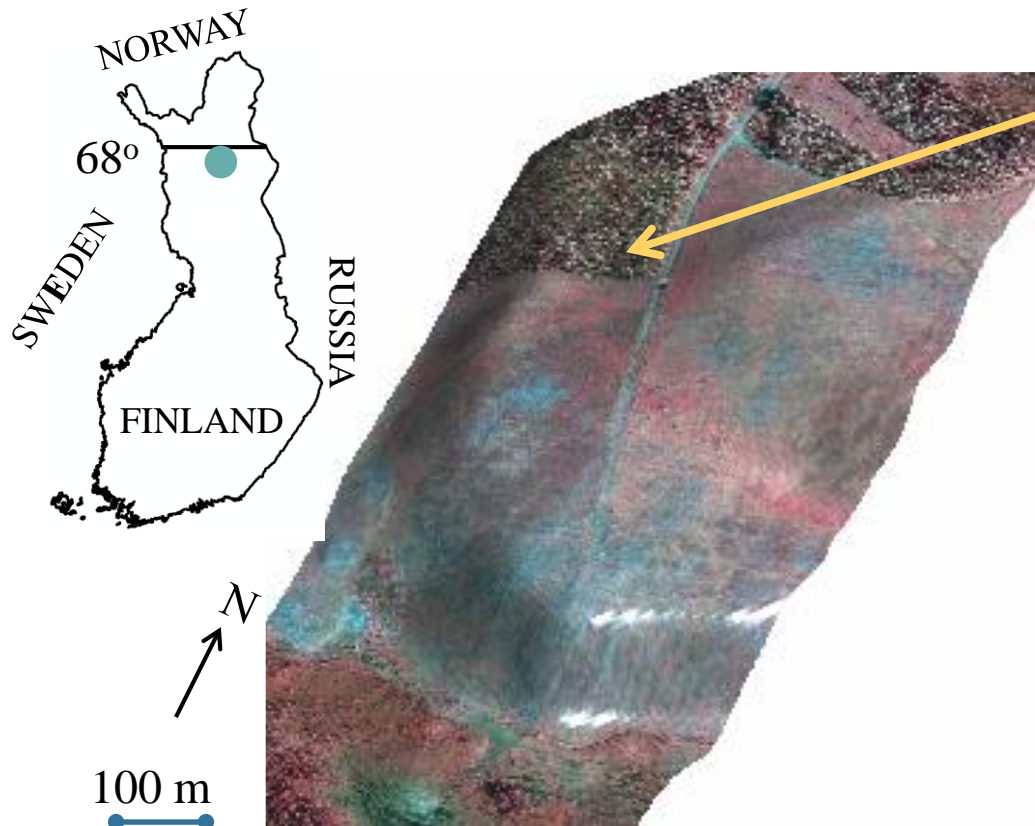
Maarit Middleton^{1, 2, 3}, Paavo Närhi¹, Raimo Sutinen¹

Geological Survey of Finland, ROVANIEMI, FINLAND, maarit.middleton@gtk.fi

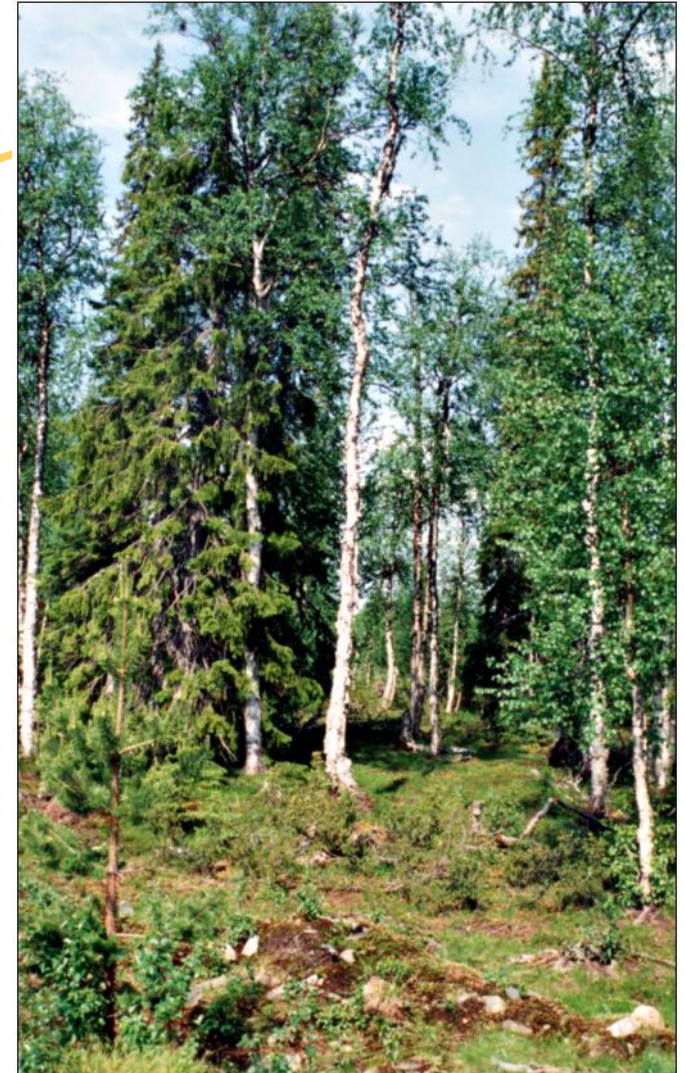
*Institute of Photogrammetry and Remote Sensing, Aalto university School of Science and
Technology, ESPOO, FINLAND*

LaRSEES, Department of Geography, Queen's University, KINGSTON, Ontario, CANADA

Ääلتövittikot study site

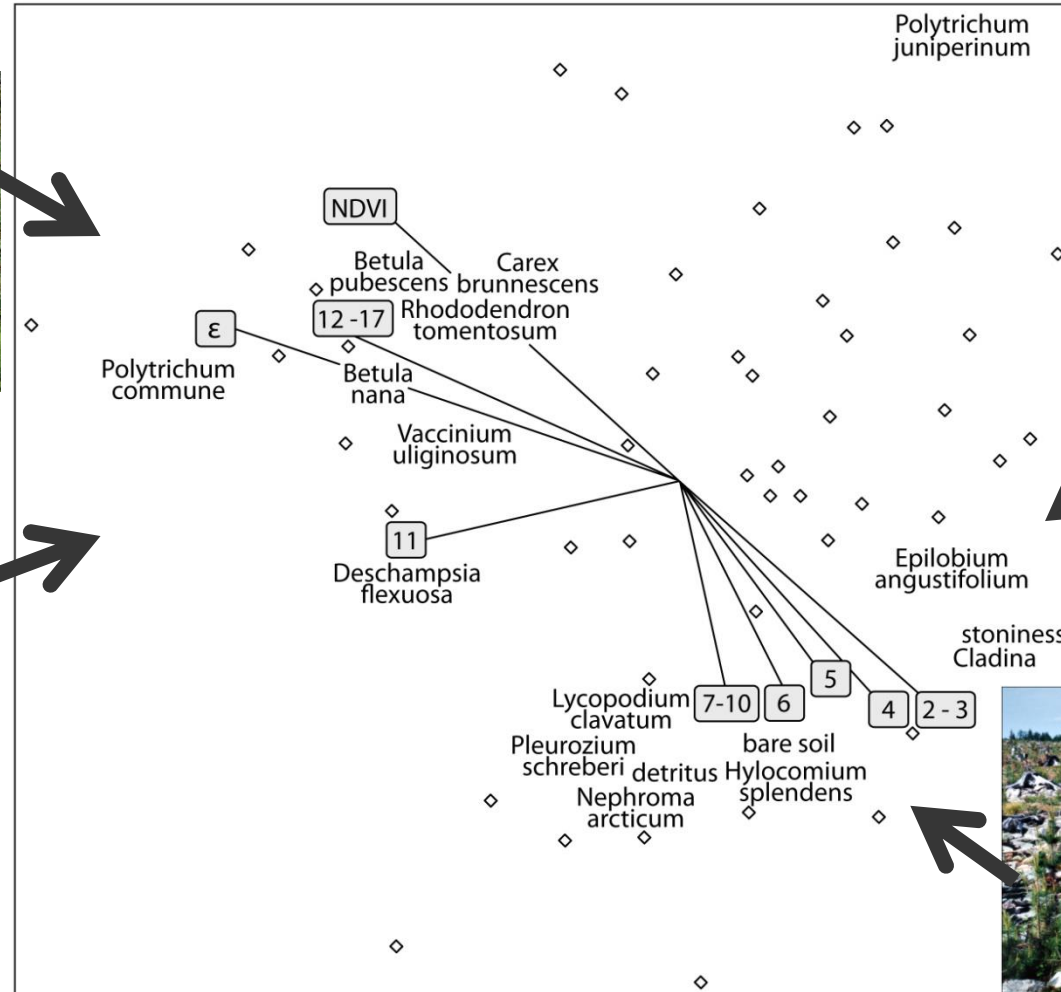


RGB false colour composite of AISA
(R=774 nm, G=644 nm, B=572 nm)



Nonmetric multidimensional scaling, NMDS ordination analysis

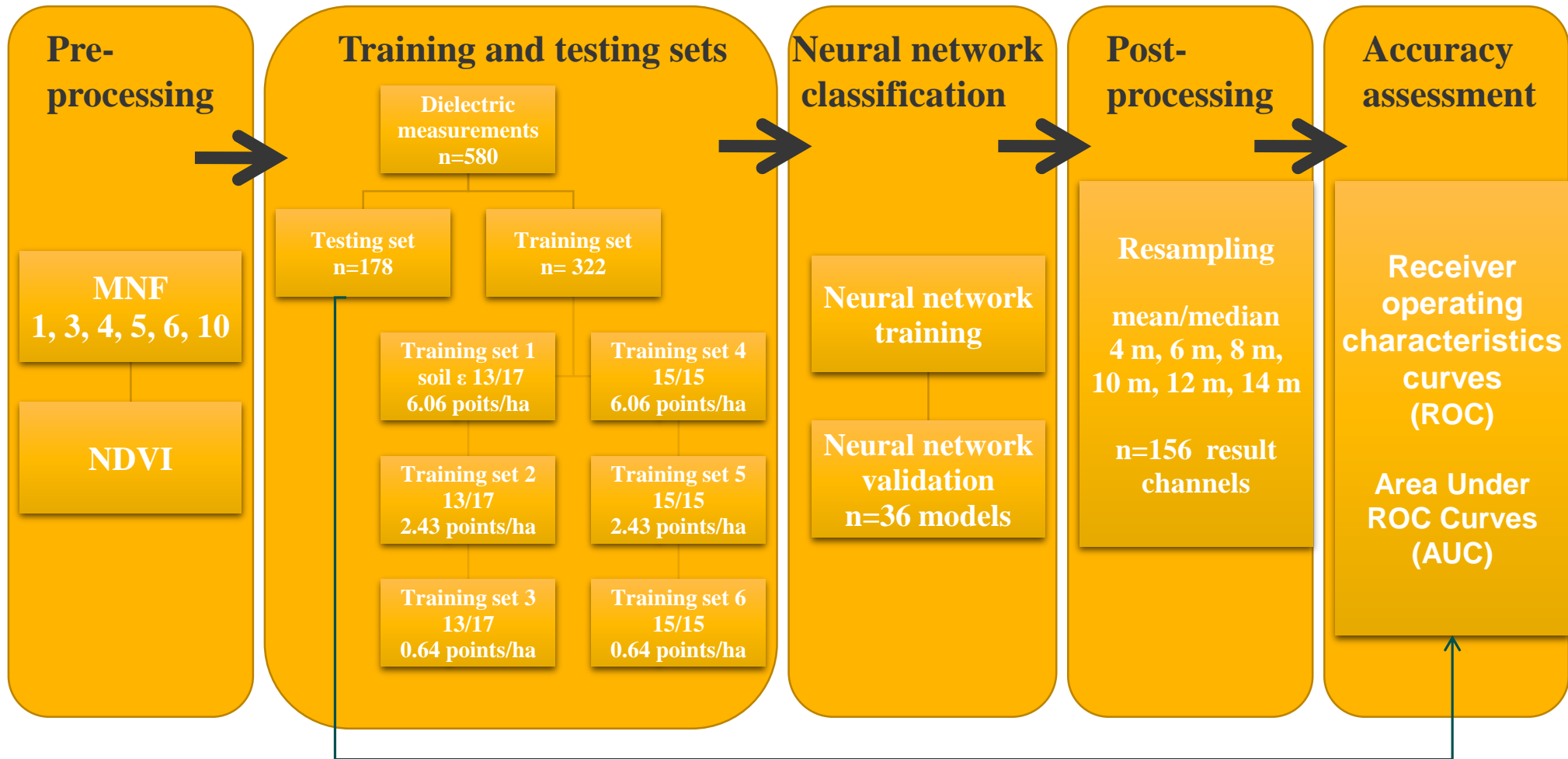
Mesic and wet sites



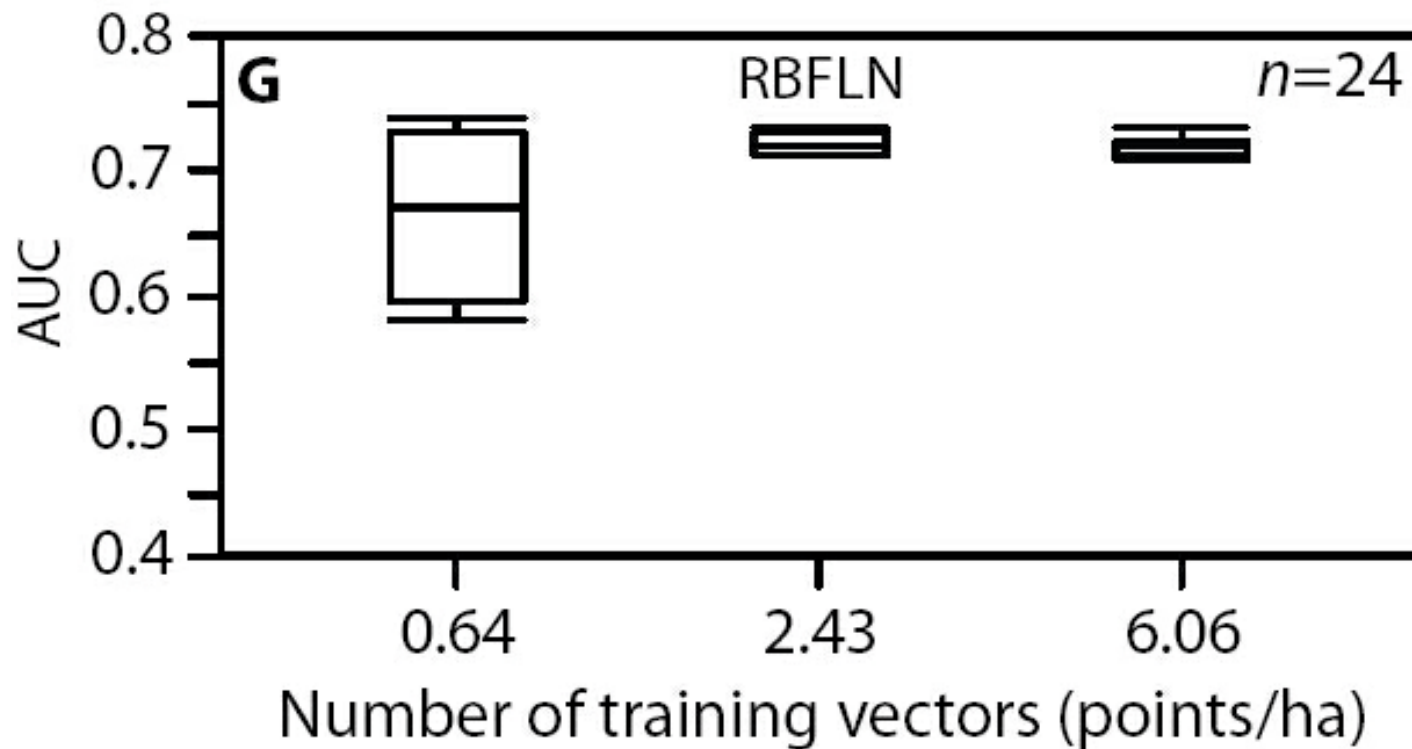
Dry sites



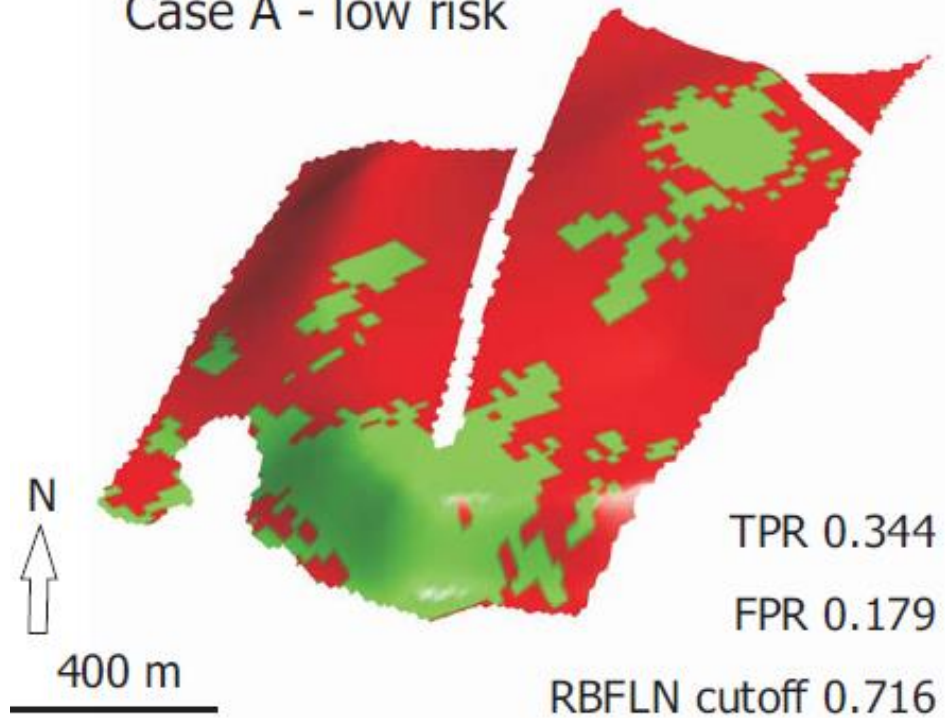
Method



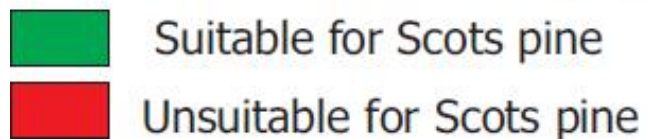
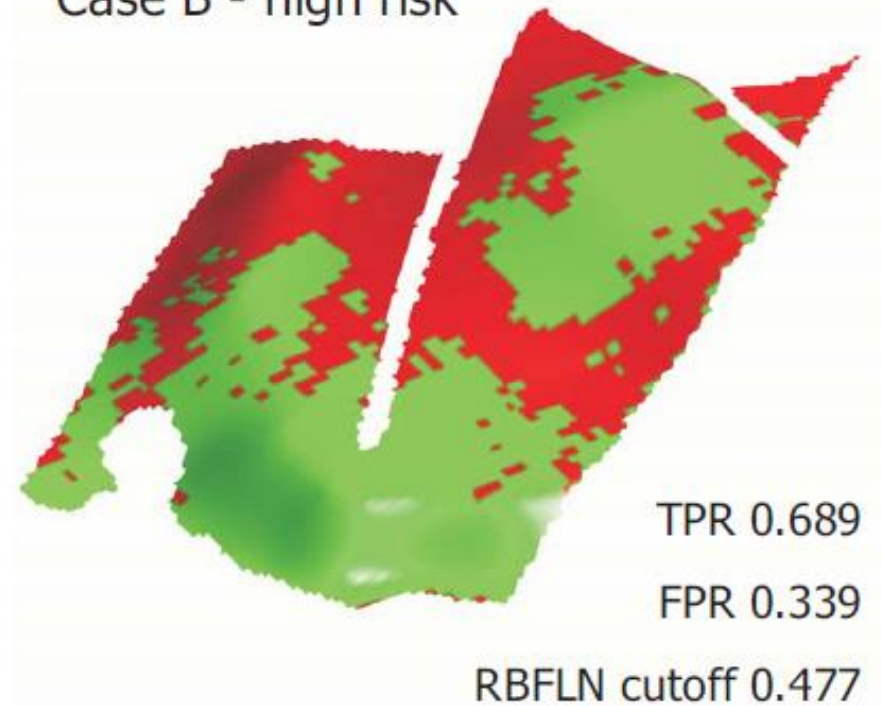
Results – Opetuspisteiden tiheyden vaikutus luokittelutulokseen



Case A - low risk



Case B - high risk



Kiitos!

maarit.middleton@gtk.fi

- Laakso, K., Middleton, M., Heinig, T., Bärs, R., Lintinen, P. 2018. **Assessing the ability to combine hyperspectral imaging (HSI) data with Mineral Liberation Analyzer (MLA) data to characterize phosphate rocks.** International Journal of Applied Earth Observation and Geoinformation 69, July 2018, 1-12.
- Middleton, M., Närhi, P., Arkimaa, H., Hyvönen, E., Kuosmanen, V., Treitz, P., Sutinen, R. 2012. **Ordination and hyperspectral remote sensing approach to classify peatland biotopes along soil moisture and fertility gradients.** Remote Sensing of Environment 124, 596-609.
- Middleton, M., Närhi, P., Kuosmanen, V. & Sutinen, R. 2011. **Quantification of glacial till chemical composition by reflectance spectroscopy.** Applied geochemistry 26 (12), 2215–2225.



Paleoseismisten sedimenttiseinämien 3D virtualitulkinta hyperpistepilvistä

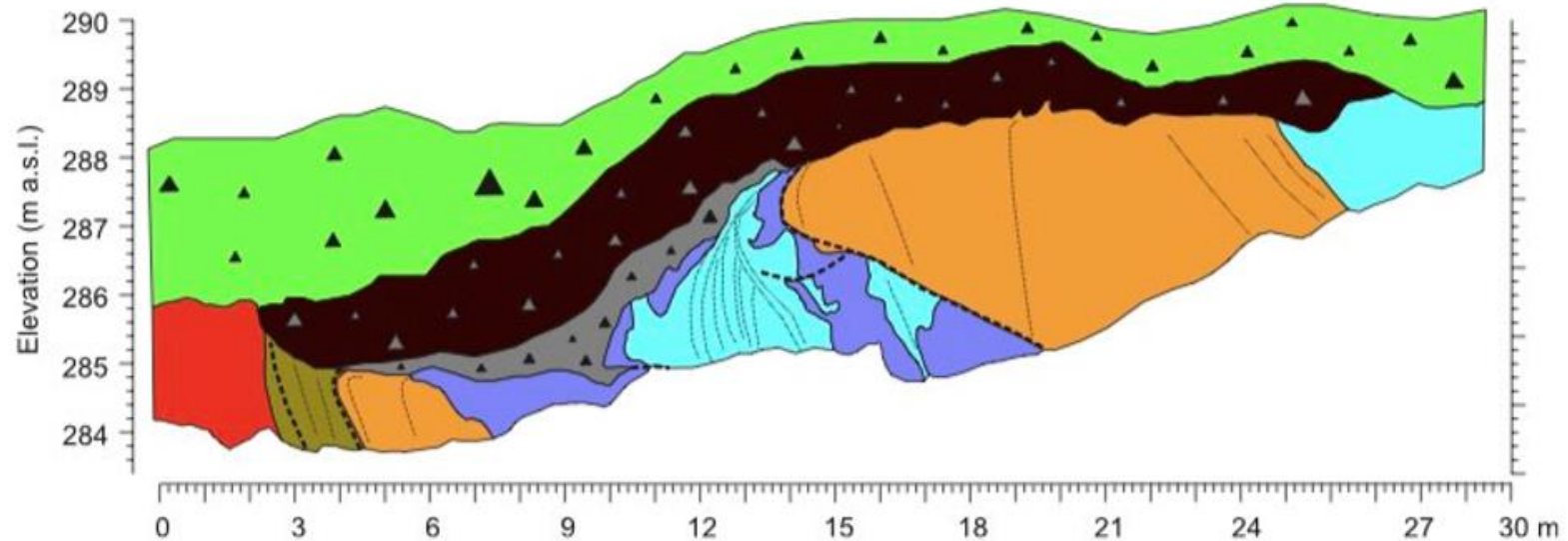
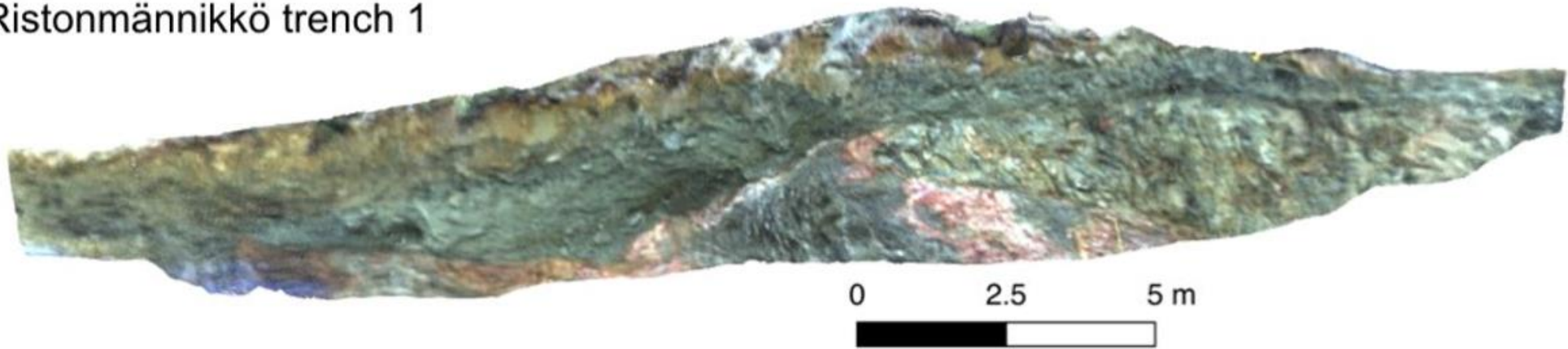
Kirsch, M., Lorenz, S., Zimmermann, R., Andreani, L., Tusa, L., Hödl, P., Jackisch, R., Unger, G., Gloaguen, R., Middleton, M., Ojala, A., Mattila, J., Nordbäck, N., Palmu, J-P., Ruskeenieni, T., Sutinen, R.

Helmholtz Institute Freiberg for Resource Technology, HZDR, Freiberg, GERMANY

Geological Survey of Finland, Rovaniemi, Espoo, FINLAND



Ristonmännikkö trench 1



Quaternary deposits

- ▲ Till (unit 1)
- ▲ Till (unit 2)
- ▲ Till (unit 3)

Bedrock

- Granodiorite
- Weathered granodiorite
- Migmatitic gneiss

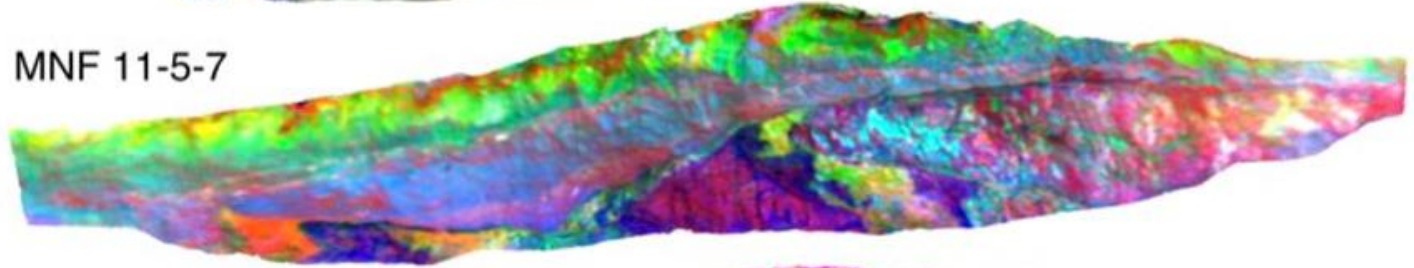
- Mica gneiss
- Pegmatitic granite

- Shear planes
- ~~~~~ Foliation

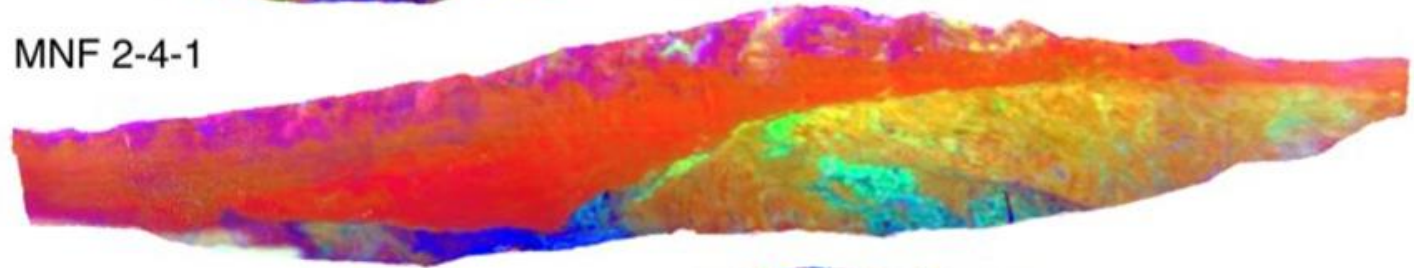
RGB



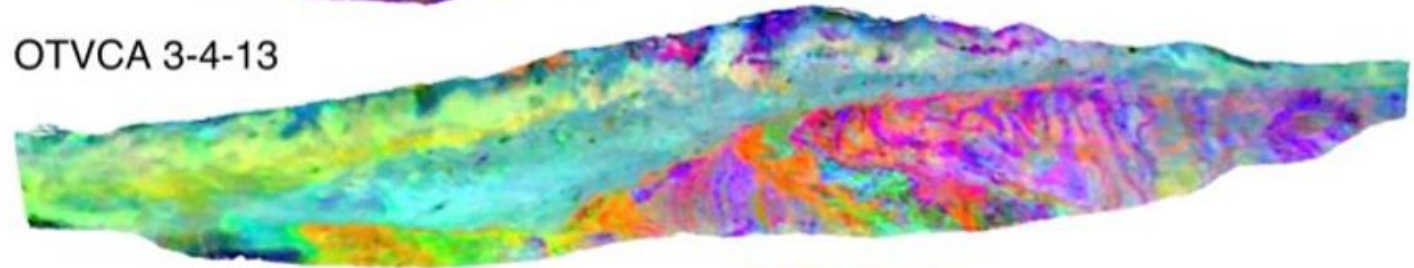
MNF 11-5-7



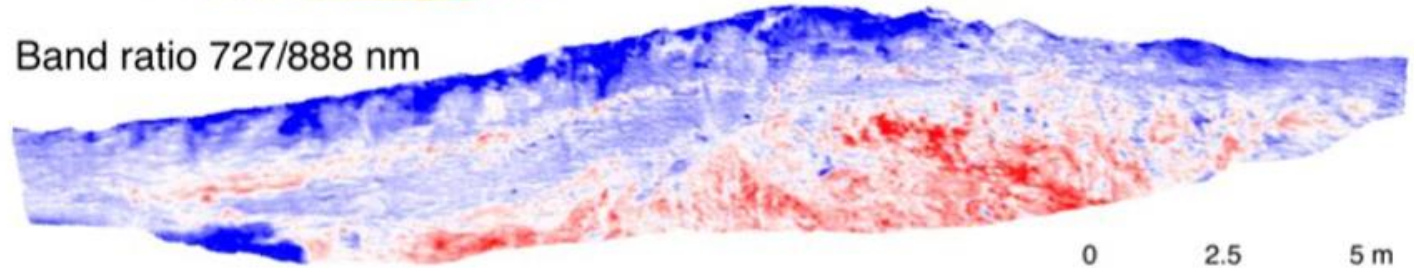
MNF 2-4-1



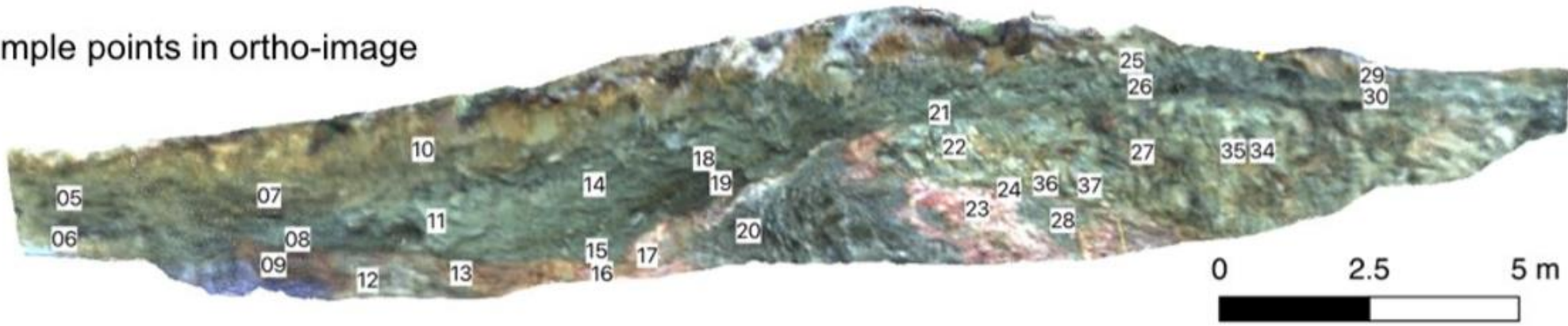
OTVCA 3-4-13



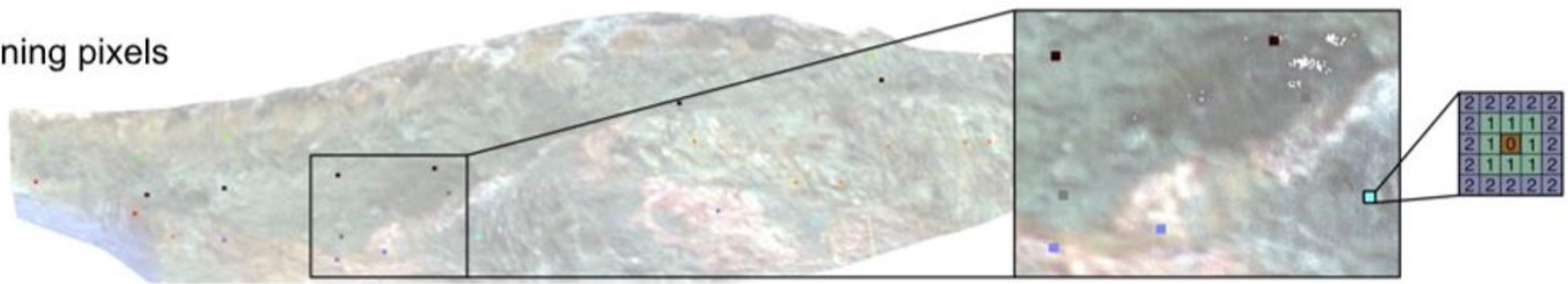
Band ratio 727/888 nm



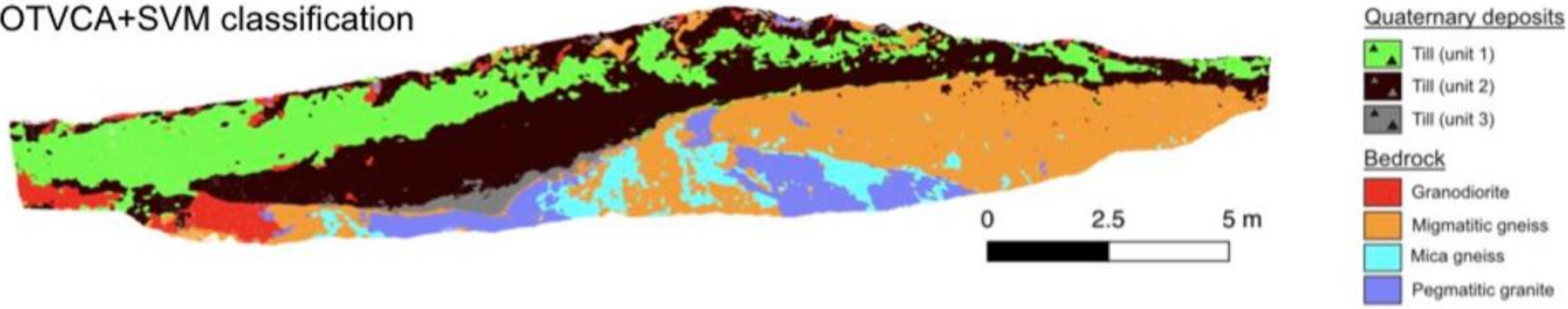
Sample points in ortho-image



Training pixels



OTVCA+SVM classification





Aapasuotyyppien tunnistus HyMap hyperspektrilentoaineistosta Keminmaalla

Maarit Middleton^a, Paavo Närhi^a, Hilikka Arkimaa^b, Eija Hyvönen^a, Viljo Kuosmanen^b, Paul Treitz^c and Raimo Sutinen^a

^a Geological Survey of Finland, Rovaniemi, Finland

^b Geological Survey of Finland, Espoo, Finland

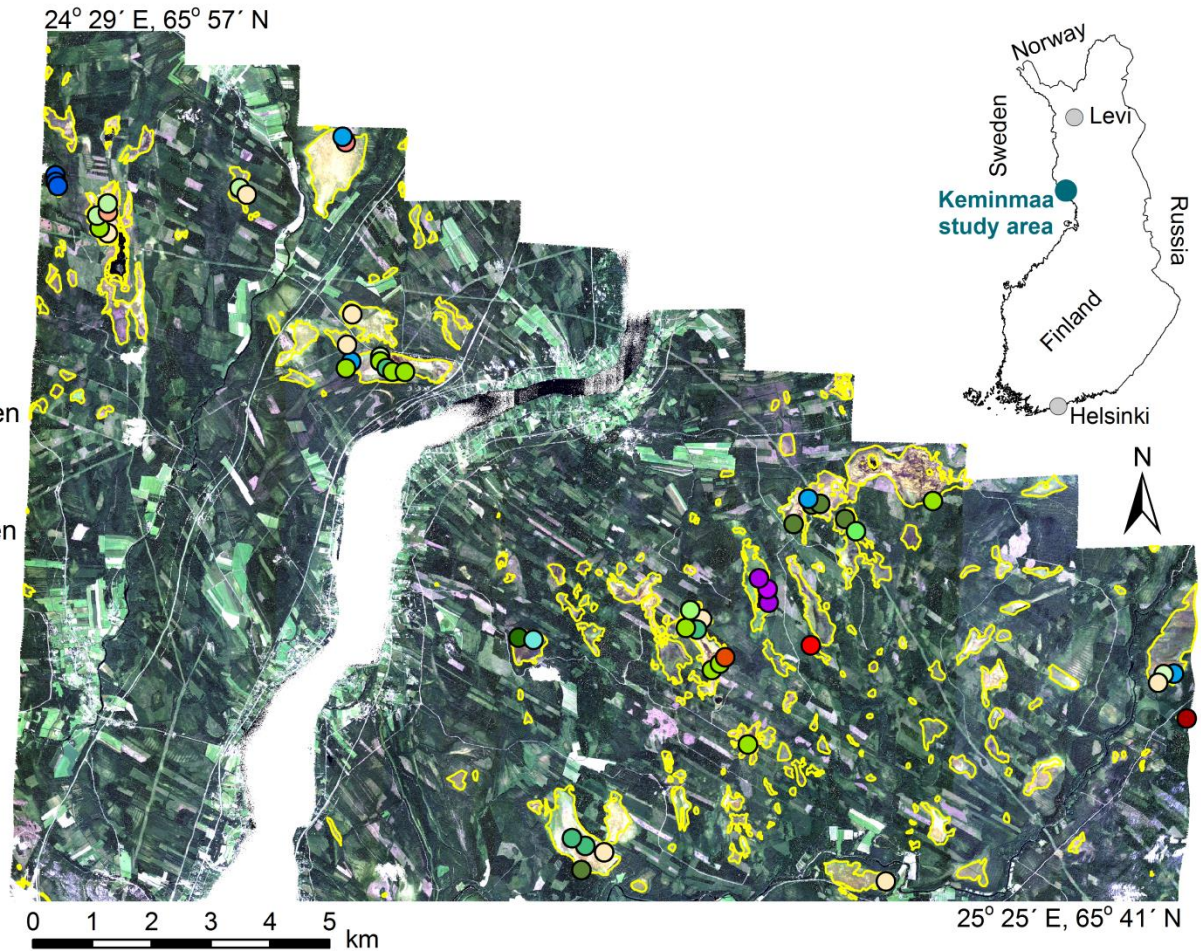
^c Department of Geography, Queen's University, Kingston, Canada

Keminmaa study area

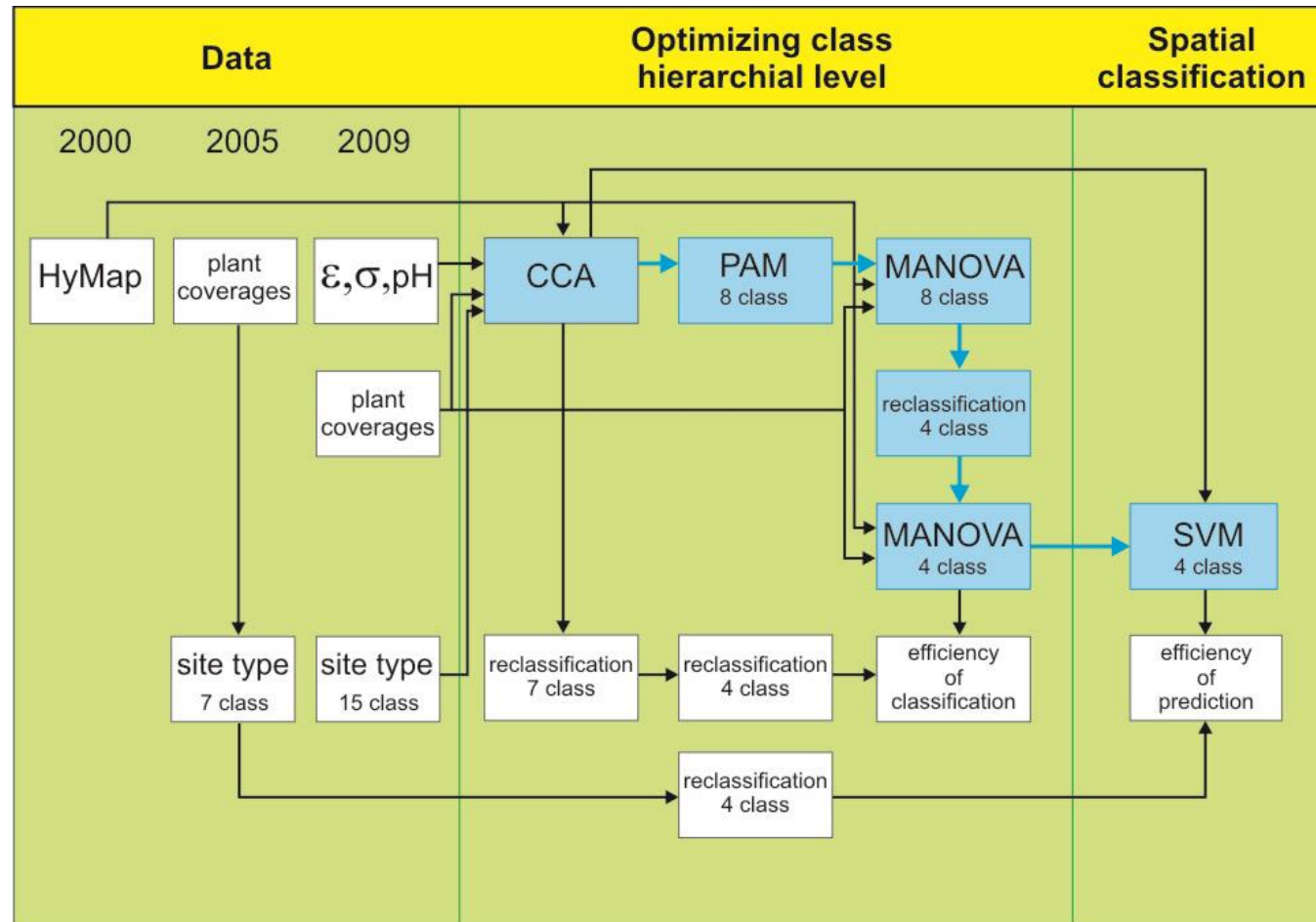
Site type

- Mesotrophic *Betula nana* Pine Bog
- Mesotrophic Low-Sedge Pine Bog
- Oligotrophic *Empetrum* Bog
- Oligotrophic Low-Sedge Pine Bog
- Oligotrophic Tall-Sedge Pine Bog
- Ombrotrophic *Empetrum* Bog
- Eutrophic Low-Sedge Fen
- Eutrophic Pine Fen
- Mesotrophic Low-Sedge Fen
- Mesotrophic *Papillosum* Tall-Sedge Fen
- Oligotrophic *Eriophorum* Fen
- Oligotrophic Low-Sedge Fen
- Oligotrophic *Papillosum* Tall-Sedge Fen
- Oligotrophic Tall-Sedge Fen
- Eutrophic *Scorpidium Flark* Fen
- Eutrophic *Warnstorffii* Fen
- Mesotrophic Tall-Sedge Fen
- Mesotrophic Tall-Sedge Swamp
- Mesotrophic Willow Swamp

 Treeless peatlands



Methods

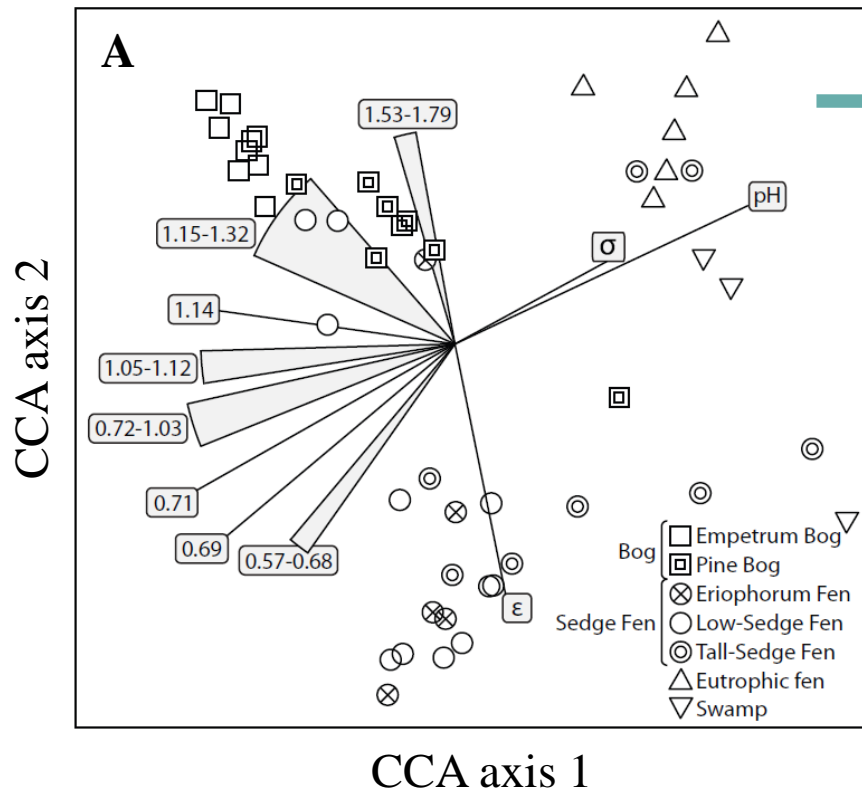


ϵ Soil dielectric permittivity
 σ Soil electrical conductivity

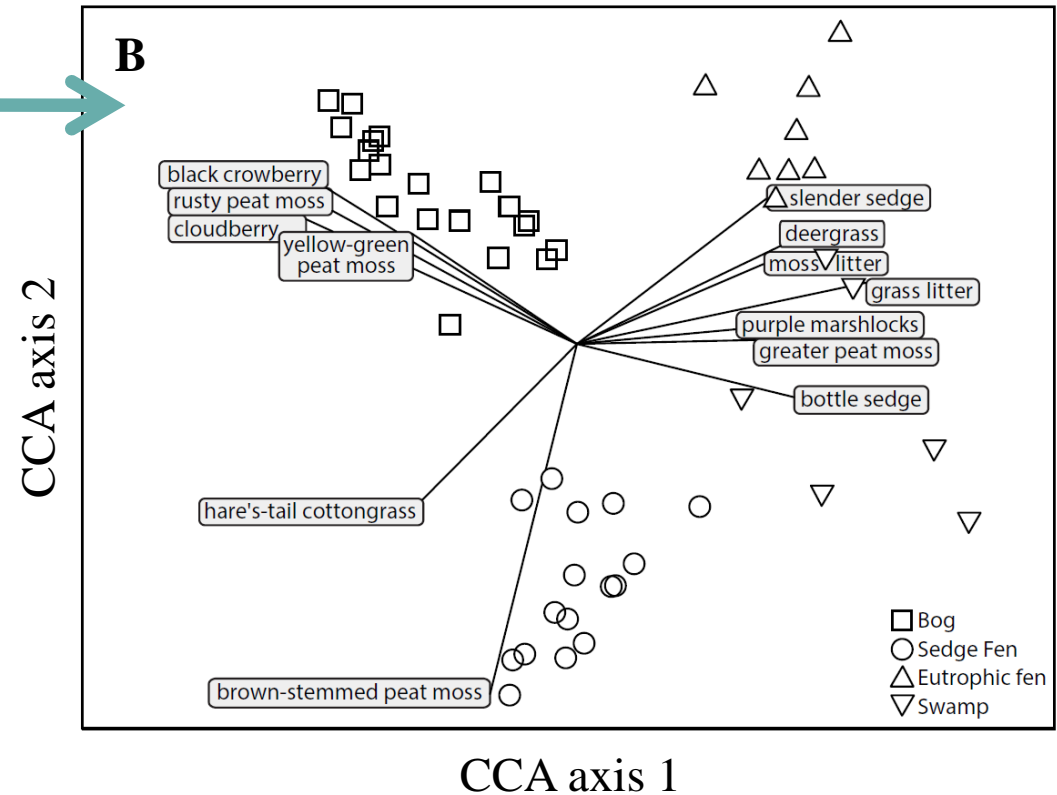
CCA Canonical correspondence analysis
 PAM partitioning around medoids, unsupervised clustering
 MANOVA multivariate analysis of variance
 SVM Support vector machines, supervised fuzzy classifier

Optimizing class hierarchical level with canonical correspondence analysis

CCA and 1st PAM clustering (7 classes)
HyMap channels overlaid

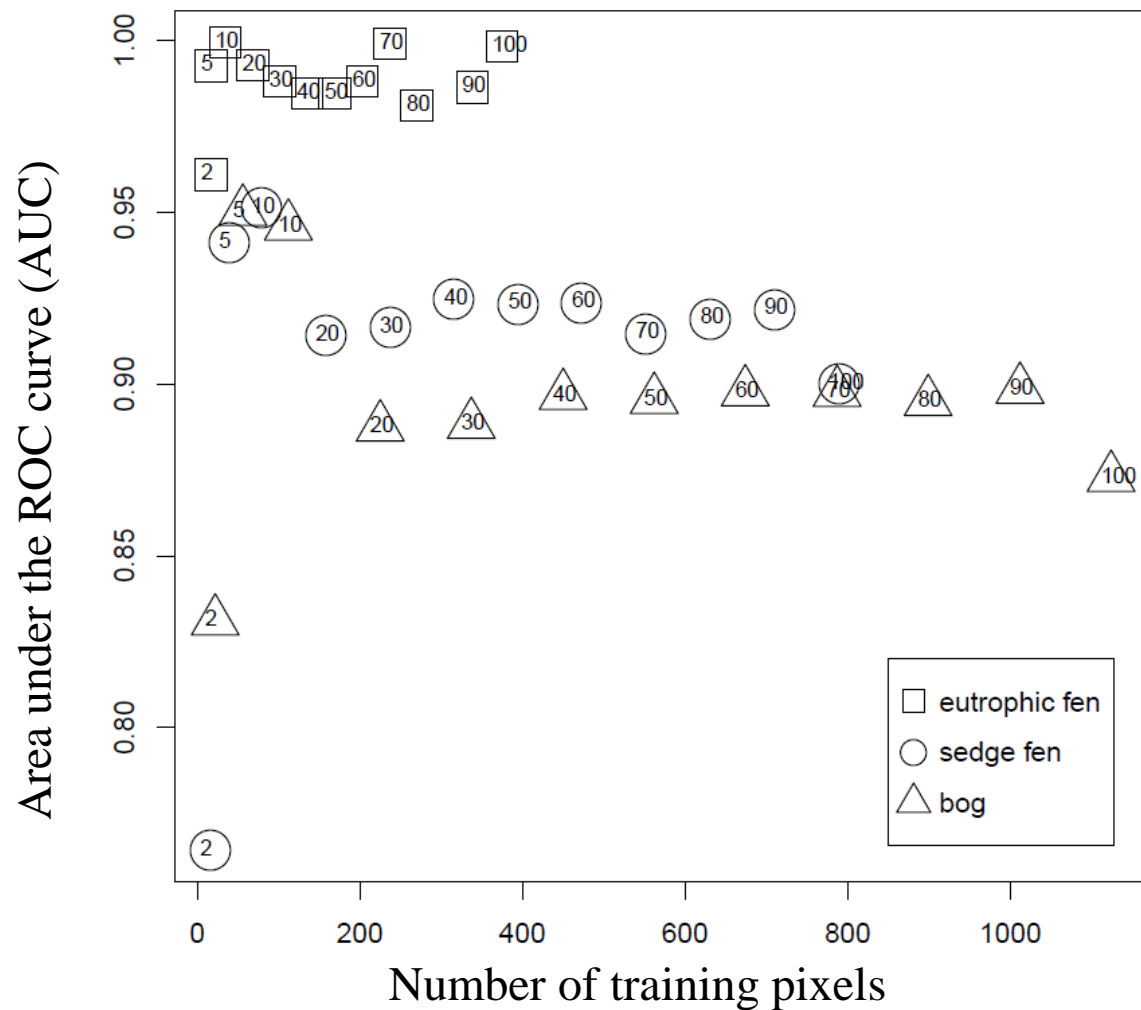


CCA and 2nd PAM clustering (4 classes)
Plant species overlaid

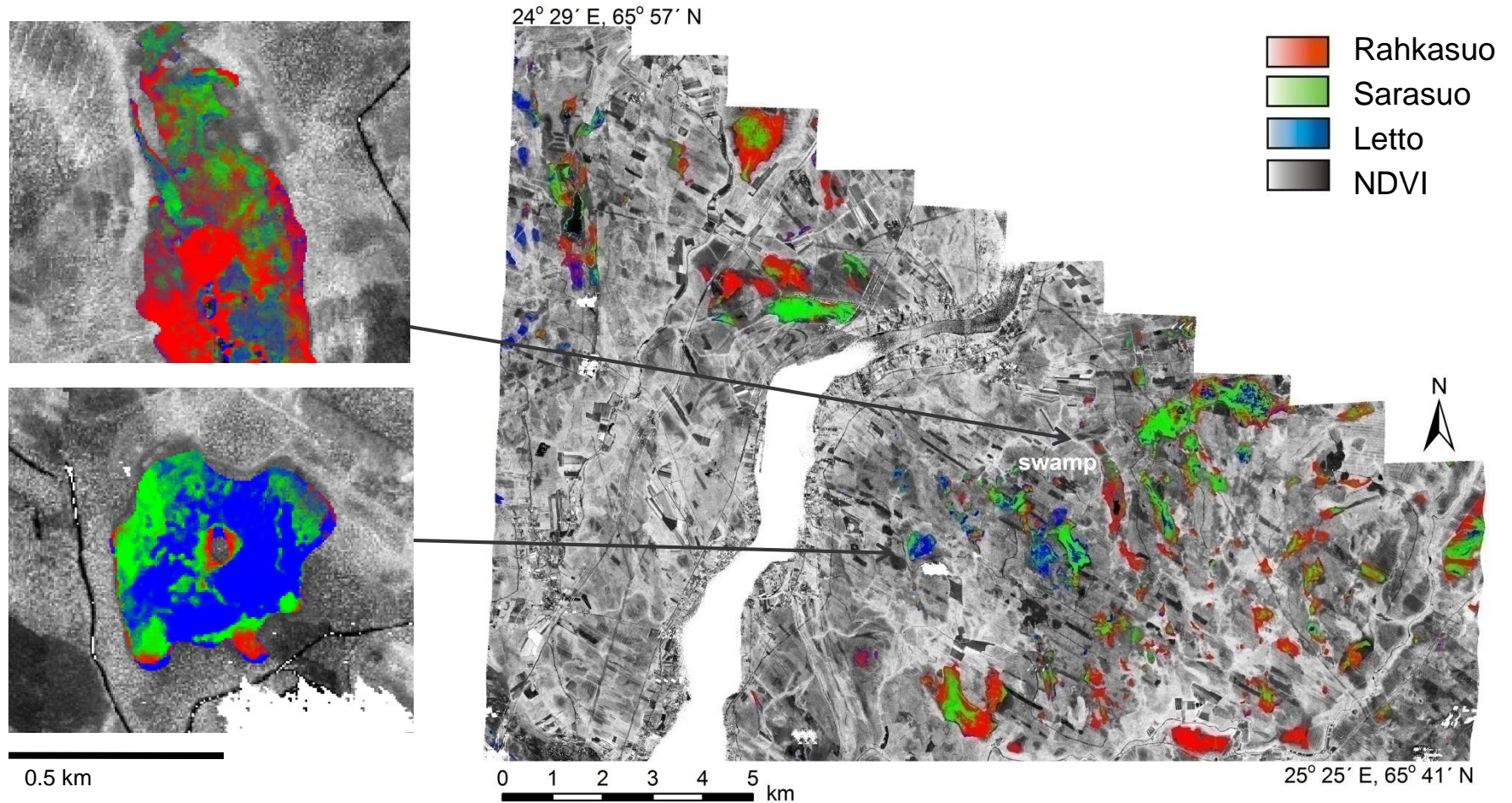


Ohjatun tukivektorikoneiluokittelun (SVM) oikeellisuus (ROC)

Number inside the shape = % of training pixels used for training a SVM model



Suotyypipiluokittelun tulos kartalla



Kiitos!

- Kirsch, M., Lorenz, S., Zimmermann, R., Andreani, L., Tusa, L., Hödl, P., Jackisch, R., Unger, G., Gloaguen, R., Middleton, M., Ojala, A., Mattila, J., Nordbäck, N., Palmu, J-P., Ruskeenieni, T., Sutinen, R. 2019. **Logging of palaeoseismic exposures in a 3D virtual environment integrating hyperspectral imagery and photogrammetric point clouds.** EGU2019-13519 | Orals | TS11.1.
- Laakso, K., Middleton, M., Heinig, T., Bärs, R., Lintinen, P. 2018. **Assessing the ability to combine hyperspectral imaging (HSI) data with Mineral Liberation Analyzer (MLA) data to characterize phosphate rocks.** International Journal of Applied Earth Observation and Geoinformation 69, July 2018, 1-12.
- Middleton, M., Närhi, P., Arkimaa, H., Hyvönen, E., Kuosmanen, V., Treitz, P., Sutinen, R. 2012. **Ordination and hyperspectral remote sensing approach to classify peatland biotopes along soil moisture and fertility gradients.** Remote Sensing of Environment 124, 596-609.
- Middleton, M., Närhi, P., Kuosmanen, V. & Sutinen, R. 2011. **Quantification of glacial till chemical composition by reflectance spectroscopy.** Applied geochemistry 26 (12), 2215–2225.
- Middleton, M., Närhi, P. Sutinen, R. 2011. **Imaging spectroscopy in soilwater based site suitability assessment for artificial regeneration to Scots pine.** ISPRS Journal of Photogrammetry and Remote Sensing 66 (3), 287-297.