# ‘Agrogeophysics’ as tool to map rocks and soil fertility

Peter van Straaten
School of Environmental Sciences
University of Guelph
Canada

# Agrogeology

There are two aspects of agrogeology:

1. Influence of parent material on soil development and soil fertility

2. Beneficial application of rocks and minerals to enhance productivity of soils: ROCKS FOR CROPS

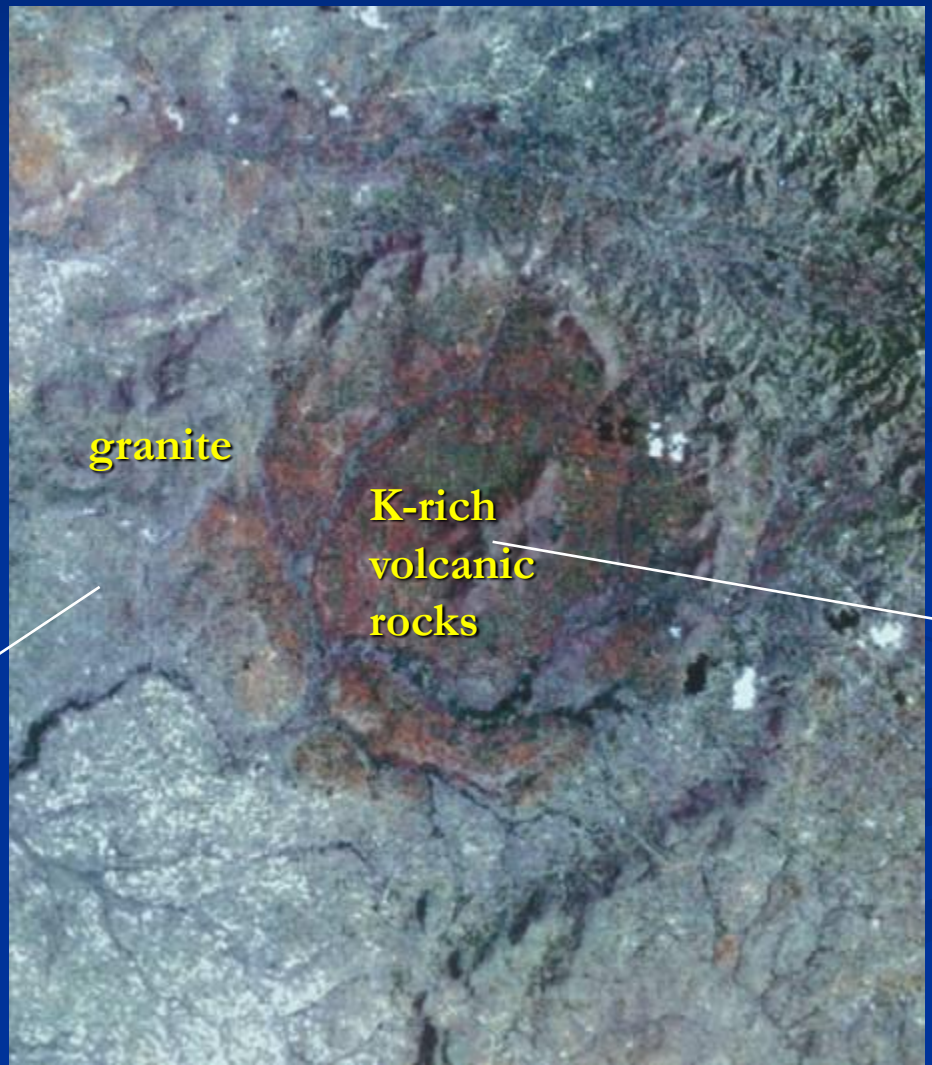
# The first aspect of agrogeology: influence of parent material on soil fertilities

- Poor soils on weathered **granitic rocks**: low nutrient status, low $H_2O$ holding capacity, sandy soils.

- Fertile soils on weathered **basaltic rocks and carbonatites**: high Ca, Mg, P and trace element concentrations,

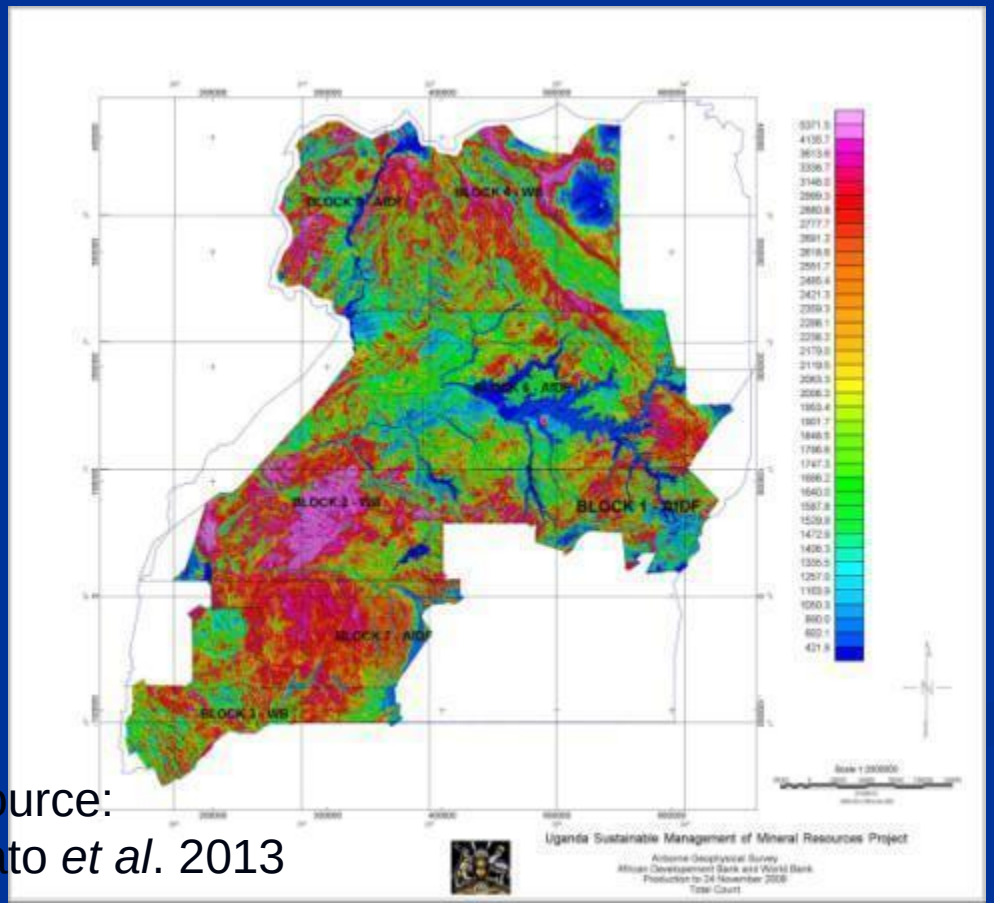
  high water holding capacity, loam.

# Effects of parent material on soil fertility: Bukusu complex, Uganda

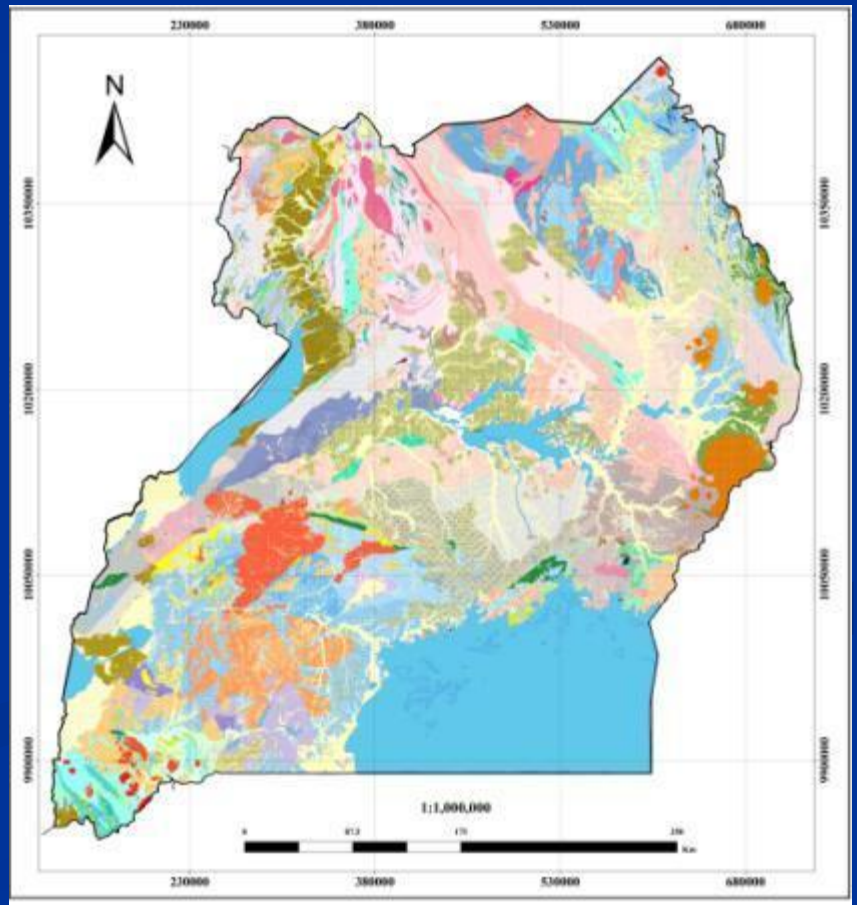



# Uganda: Identification of lithologies and structures using airborne geophysics

Total count




Geology and K (%)

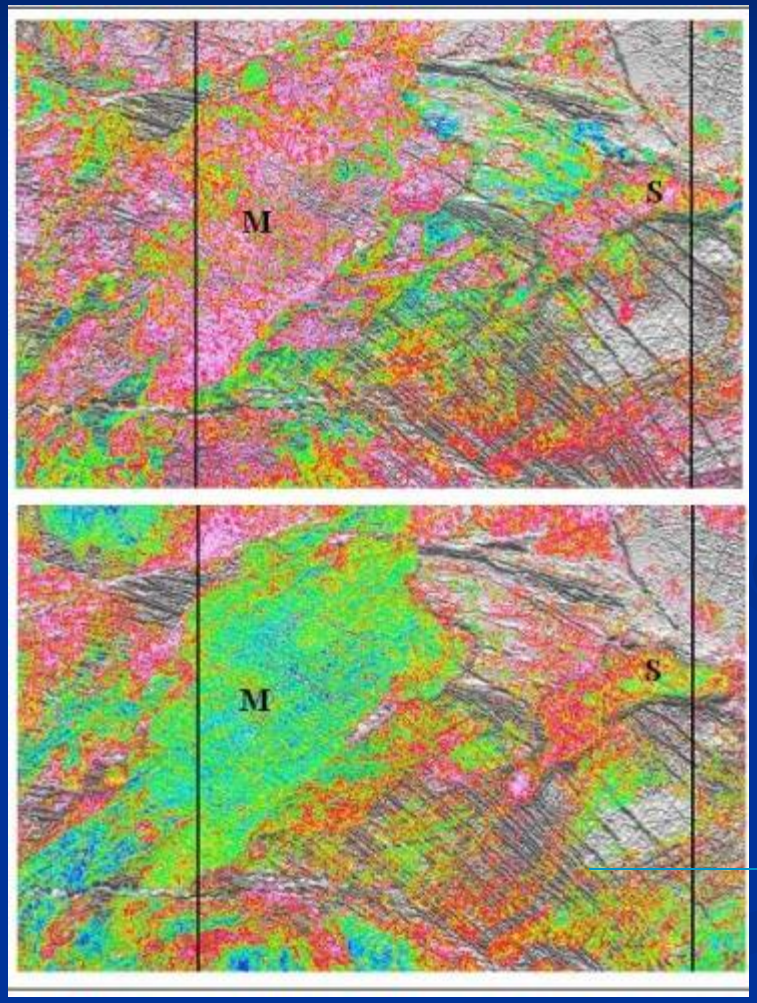



Source:
Kato *et al*. 2013

# Uganda: Identification of lithologies and structures using airborne geophysics

M= Mubende granite

S = Singo granite



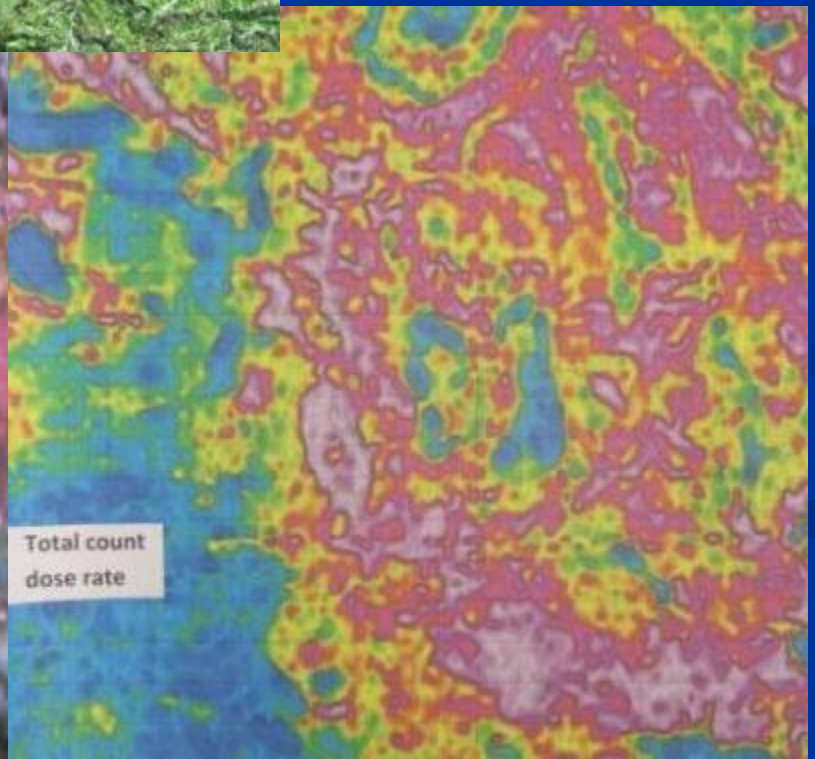

U/K ratio

U/Th ratio

Dolerite dyke swarm

Source: Ruotoistenmäki *et a*l. 2011

# Delineation of structures and lithologies


5 km

# Soil fertility on different parent materials in tropical countries

- **High** over mafic rocks, volcanics, metamorphic (amphibolites), dolerites (generally low K)
- **High** over carbonates, anorthosites, glauconite bearing sediments

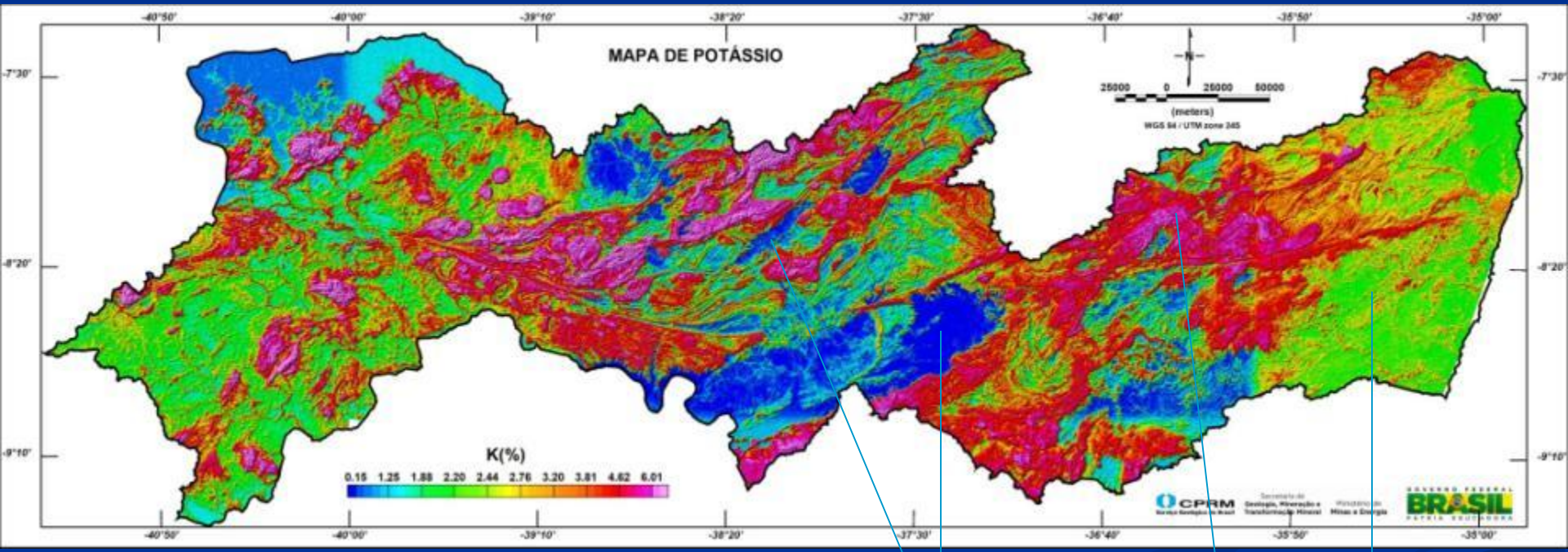
- **Variable** over gneisses

- **Low** over quartzites, sandstones, granites (with exceptions)
- Frequently **low** over ultra-mafics (Ni and Cr toxicities)

# Joint geological-geophysical surveys: Use of portable geophysical and analytical tools

- Geological studies
- Magnetic susceptibility meter
- Gamma ray spectrometer
- Portable XRF


# Airborne radiometric surveys outlining areas with different K concentrations (in %K) in soils and regoliths




**in % K**

Low total K, sandy soils Jatoba Basin

High total K I-type granites

Highly K-leached soils

Source: Roberto Gusmão *et al*, in prep.

# NE Brazil: Differing soil fertilities over different granites

- I-type granites vs s-type granites

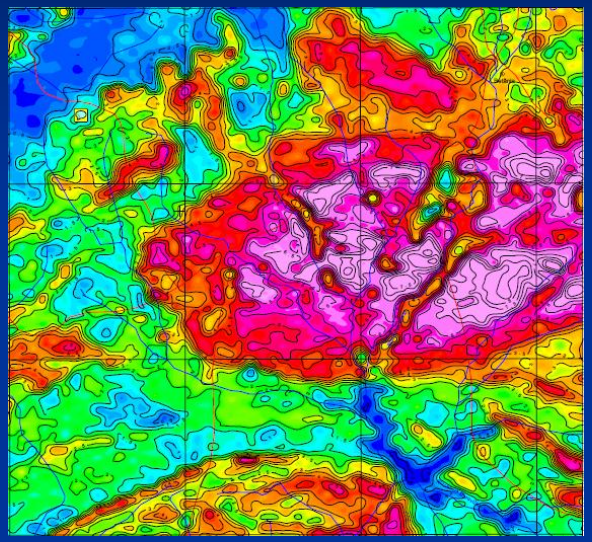
# I- and S-type granites produce different soil fertilities in NE Brazil

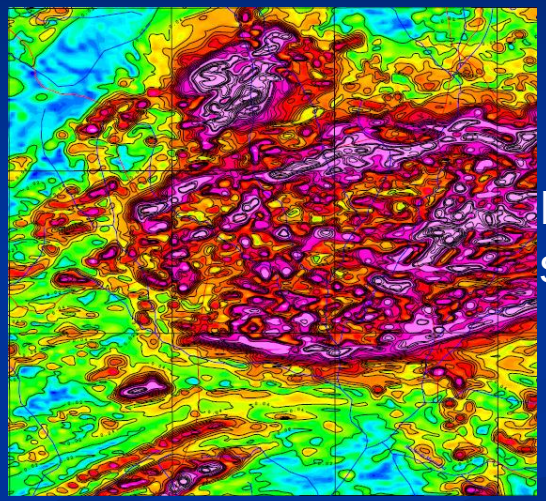
- I-type granite: Quartz (30%), plagioclase, biotite, hornblende, augite, magnetite
- **Soil fertility: <u>medium</u>,** elevated Ca, Mg, P and K + Zn

- S-type granite: Quartz (46%), K feldspar, Plagioclase, muscovite
- **Soil fertility: <u>very low</u>,** low P, medium K, Al-toxicity

# Geophysical signals of I type granite: high magnetic susceptibility, high K, low Th

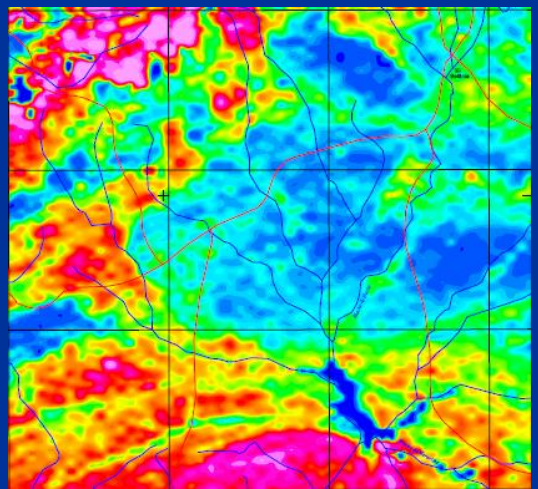
K (%)





Magnetic signal

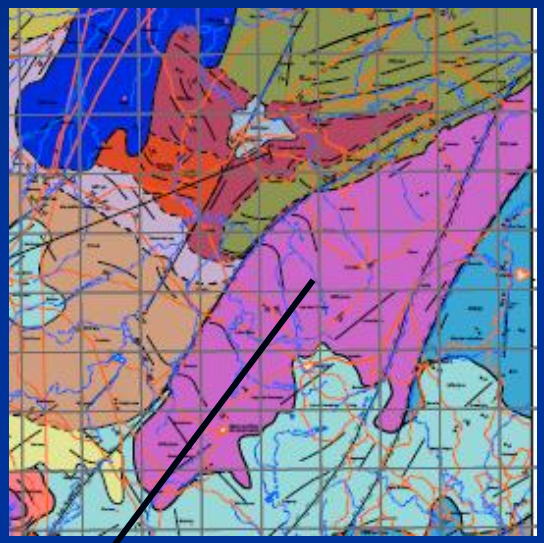
eTh/K



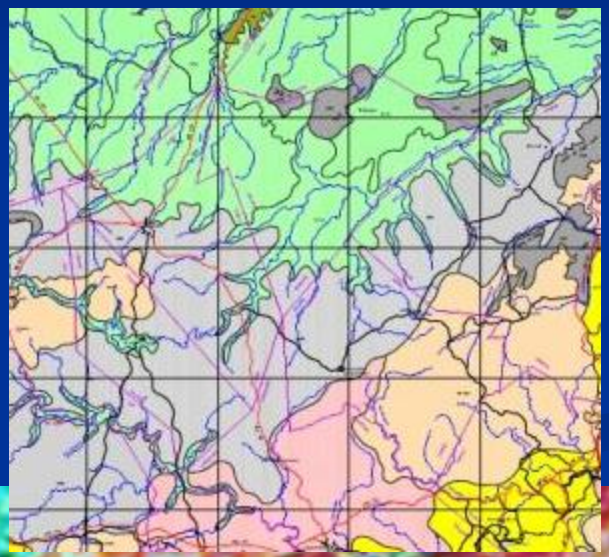

High magnetic susceptibility

Medium Total count

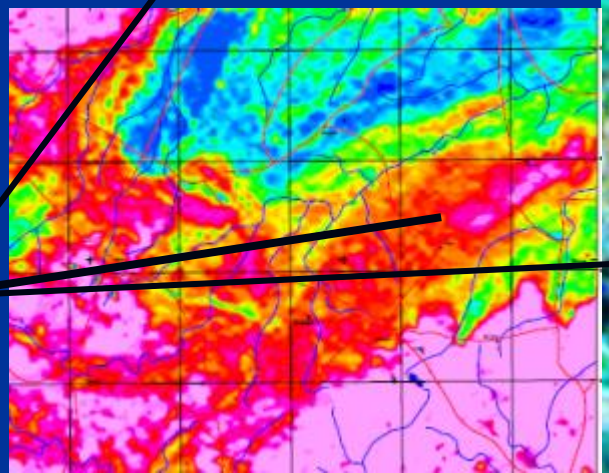
# Geophysical mapping of s and i-type granites outlining different soil fertilities



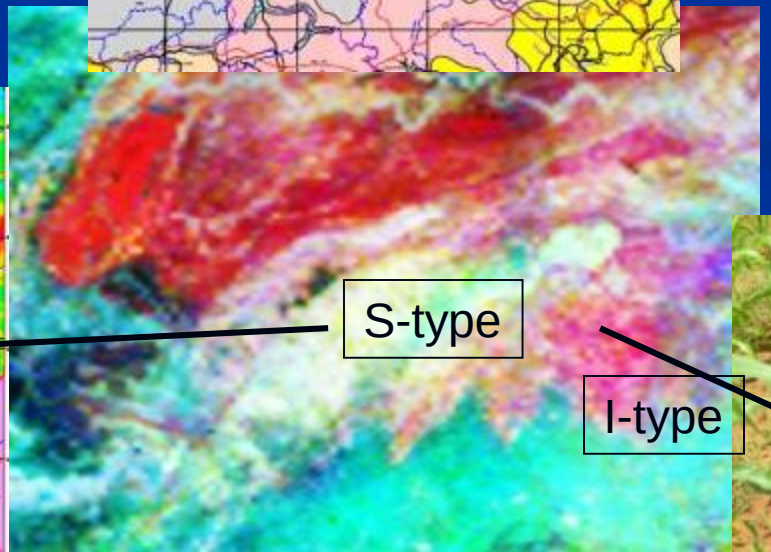
Geology



Soils



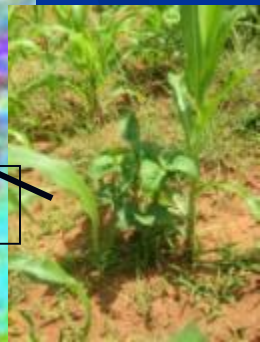
eTh/K



Ternary plot

S-type

I-type



# Passira Anorthosite

- **High soil fertility** over anorthosite body in NE Brazil – **except for K**


Low total count

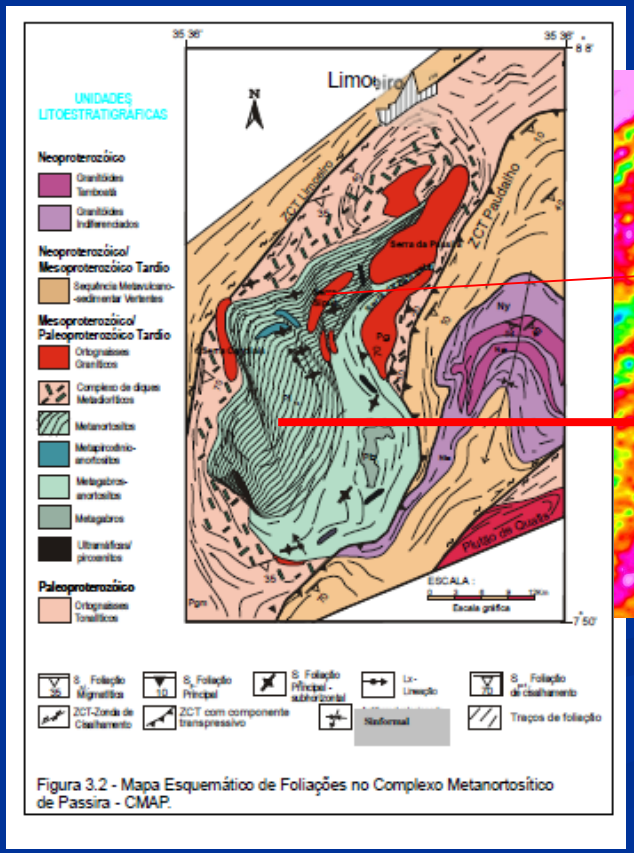
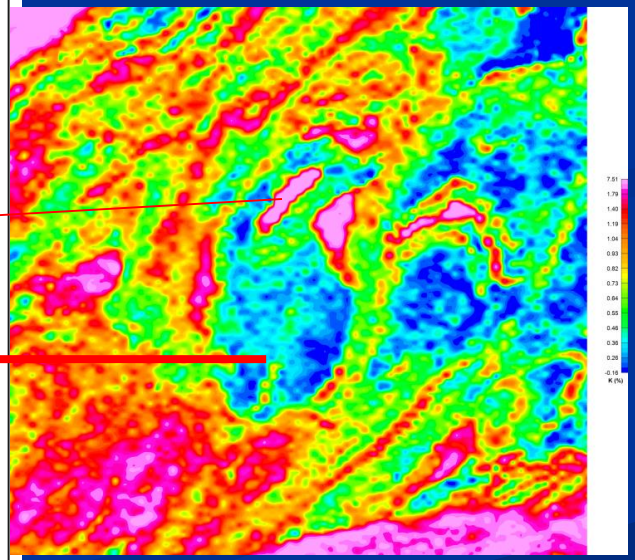


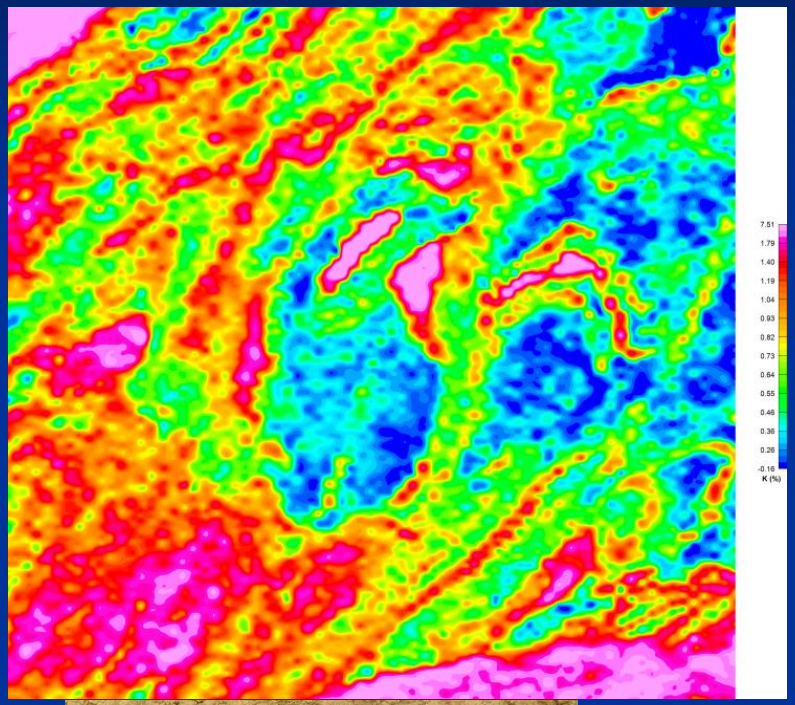

Figura 3.2 - Mapa Esquemático de Foliações no Complexo Metanortosítico de Passira - CMAP.

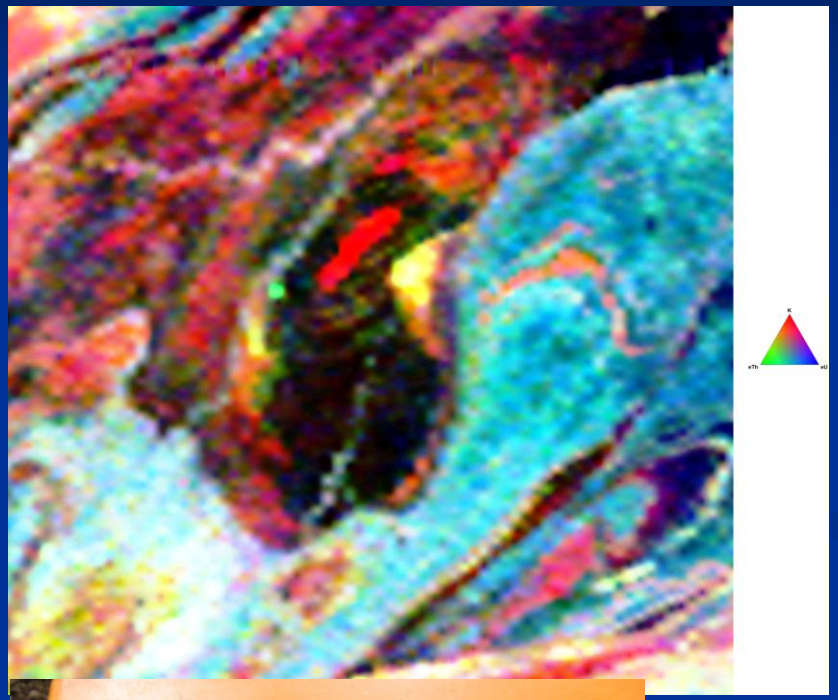


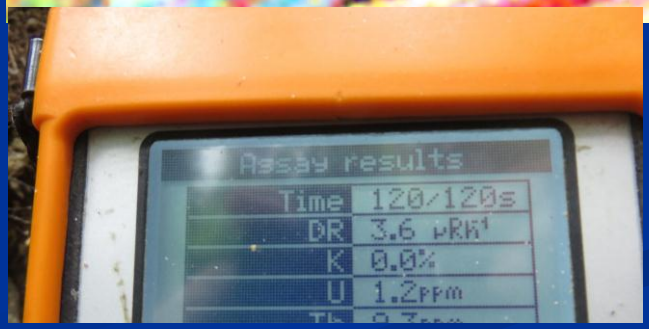
Airborne geophysical survey shows low total K radiation

Source: Accioly 2000

# Passira anorthosite







# Studying shoshonites in Pernambuco State

# ‘Rocks for crops’ to alleviate soil infertility over anorthosites?



Rock types: syenite and shoshonite

# Outlook

- Airborne and ground geophysical surveys are novel additional tools for rapid soil mapping and powerful tool in identifying certain exploration targets for agrogeological resource discoveries

- Ground geophysical surveys - in combination with geological and geochemical exploration methods - are powerful tools in delineating agrogeological resources for 'rocks for crops' applications (example shoshonite application for K-deficient Passira anorthosite)