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X SIMPÓSIO BRASILEIRO DE EXPLORAÇÃO MINERAL
X BRAZILIAN SYMPOSIUM ON MINERAL EXPLORATION

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HÁ MAIS DE 50 ANOS **GERANDO** E **DISSEMINANDO** O CONHECIMENTO GEOCIENTÍFICO COM **EXCELÊNCIA**

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SECRETARIA DE **GEOLOGIA, MINERAÇÃO E TRANSFORMAÇÃO MINERAL**

MINISTÉRIO DE **MINAS E ENERGIA**

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Aplicações da Espectroscopia de Reflectância na Prospecção de Pegmatitos Litiníferos

Reflectance Spectroscopy (RS) Applications for Lithium Pegmatites Prospection

Estudos de caso na Área do Médio Rio Jequitinhonha e Província Pegmatítica Borborema.

Examples from the Middle Jequitinhonha River Area (MJR) and Borborema Pegmatite Province (BPP)

Mônica Mazzini Perrotta

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Laboratory of Remote Sensing and Mineral Spectroscopy (LABSERGEM)
Divisão de Sensoriamento Remoto e Geofísica (DISEGE)
Diretoria de Geologia e Recursos Minerais (DGM)

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REFLECTANCE SPECTROSCOPY

Basic concept

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Interaction of Electromagnetic Energy of Light with the surface materials

Reflection

Absorption

Transmission

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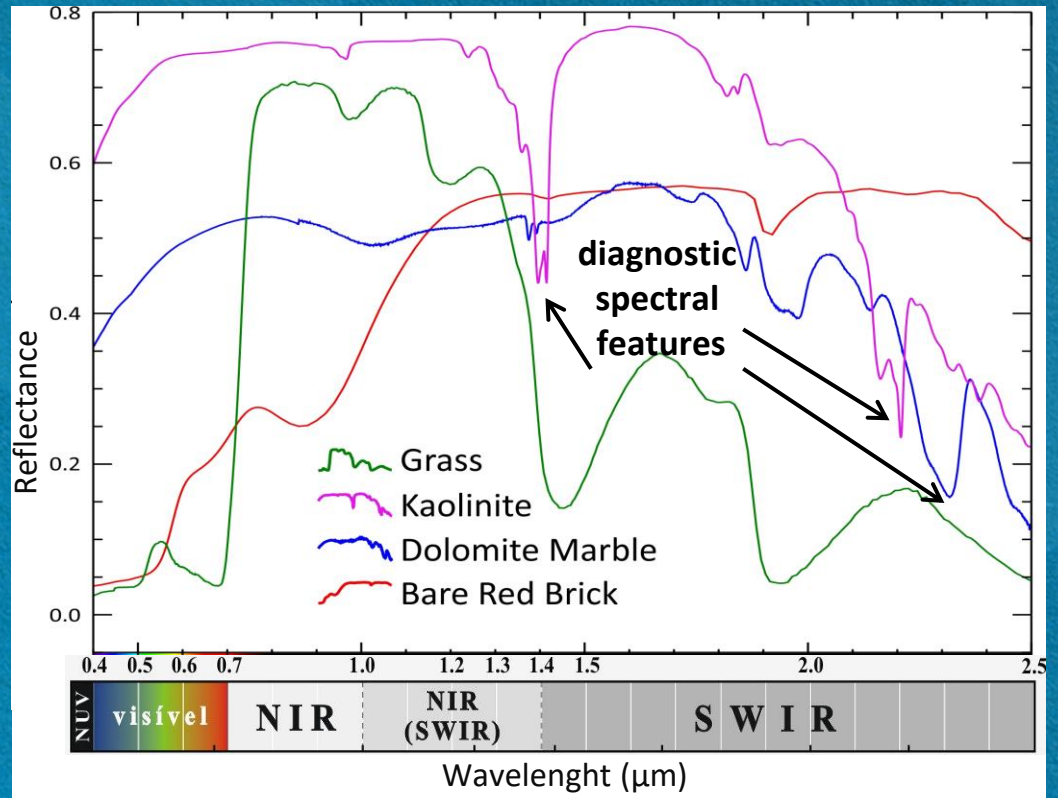
Reflectance

The ratio of reflected energy to incident energy

Varies with wavelength as an effect of molecular properties of the materials

Reflectance Spectral Signature: A plot of the reflectance of a material as a function of wavelength



LABORATORY ANALYZES OF REFLECTANCE SPECTROSCOPY

ASD - FieldSpec®3 Hi-Res

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PURPOSE OF USING THE REFLECTANCE SPECTROSCOPY IN LITINIFEROUS PEGMATITES PROSPECTION

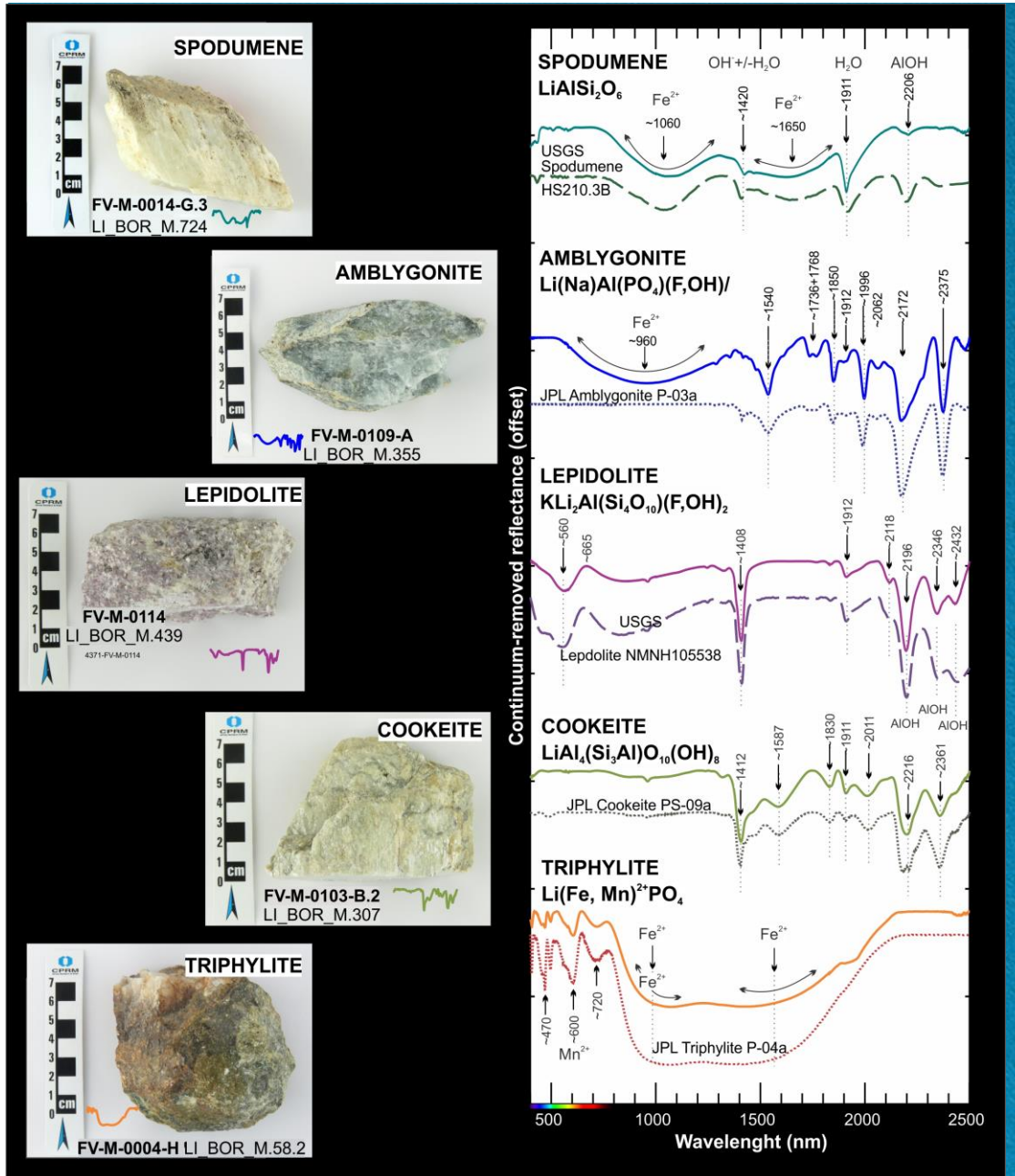
- **Define the characteristic spectral signatures and diagnostic features of the mineral assemblages of lithium ore and gangue, wall and host rocks, and its products of hydrothermal or weathering alteration;**

- **Establish possible relationships between spectral absorption features and the variation in lithium content in Li-minerals. As specific features related to the Li^+ cation bond could not be clearly identified, these features may constitute indirect prospective evidence;**

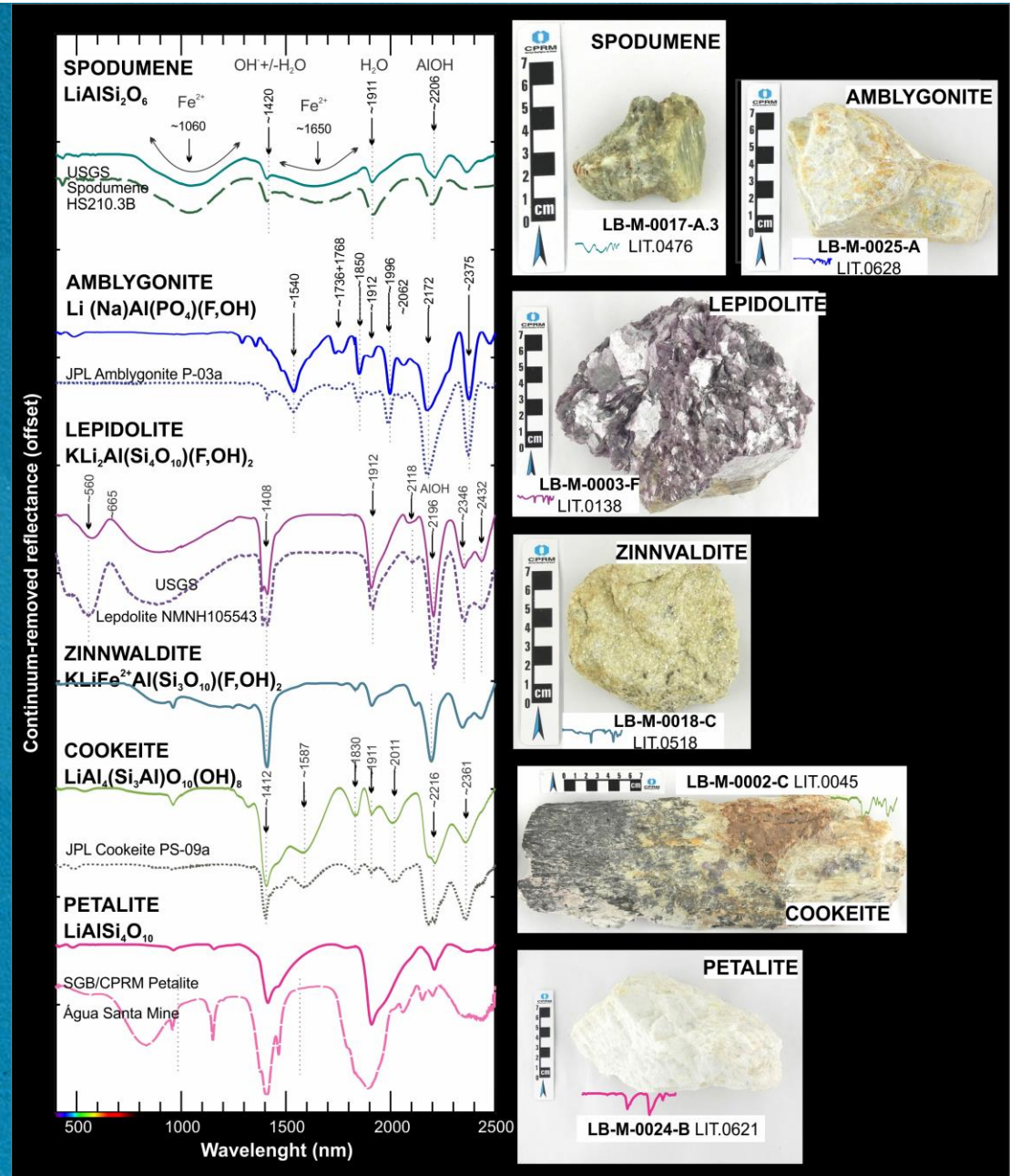
- **Define reference spectra to look for new deposits in remote sensing data.**

SPECTRAL LIBRARIES OF LITHIUM MINERALS

Borborema Pegmatite Province - BPP



Middle Jequitinhonha Area - MJR



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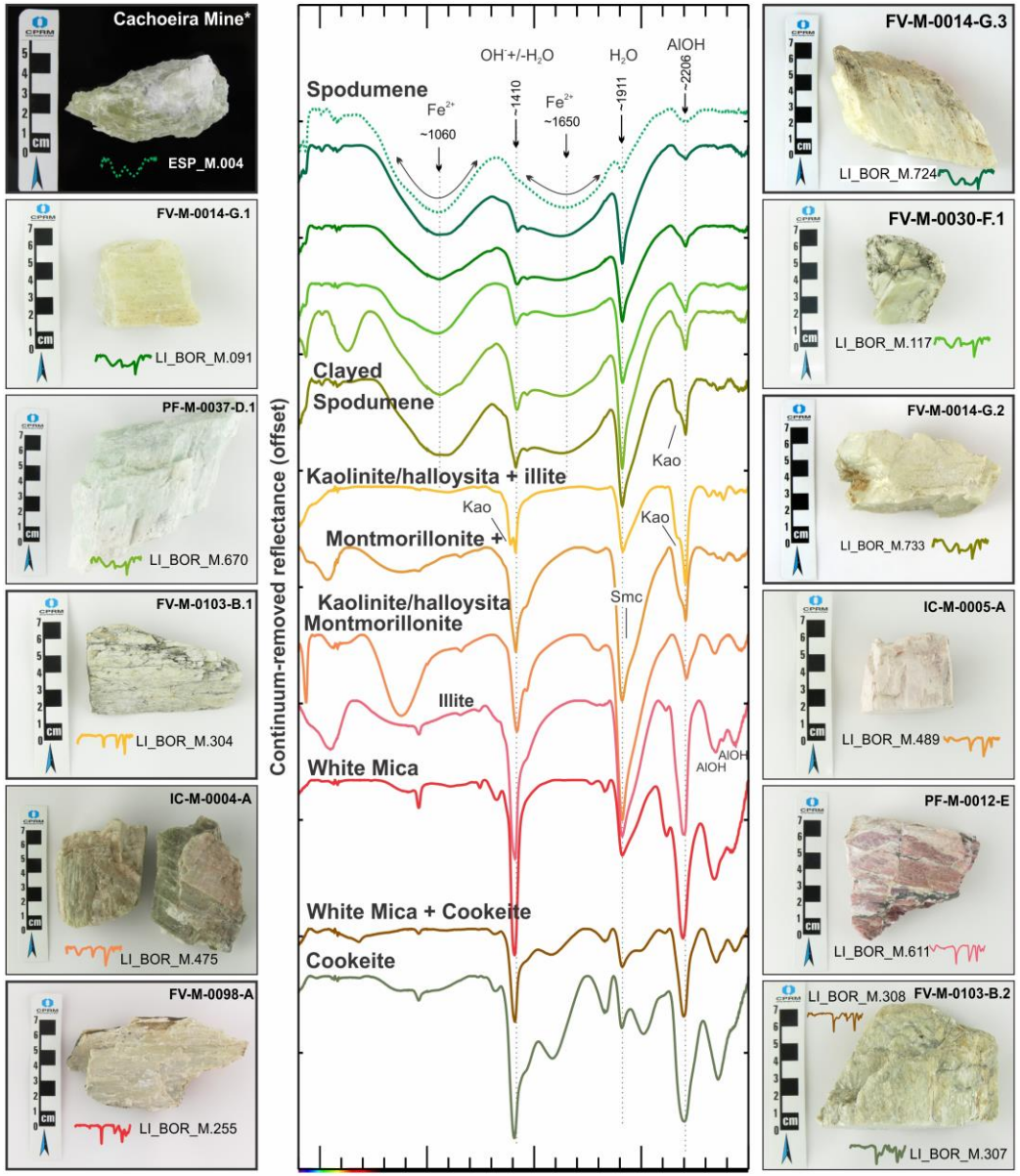
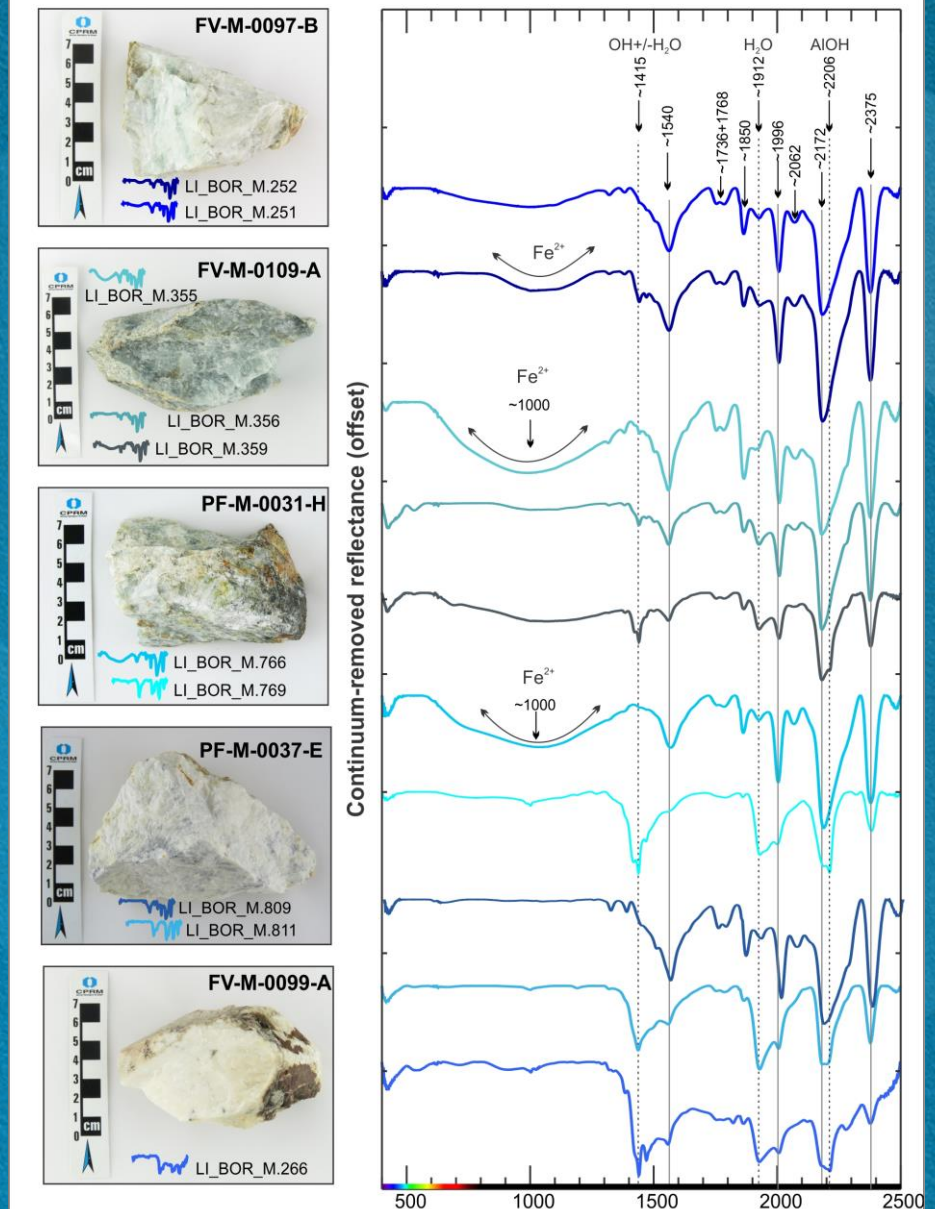
SPECTRAL SIGNATURES OF Li-ORE MINERALS - BPP

SPODUMENE

* Acknowledgement to Companhia Brasileira de Lítio - CBL

AMBLYGONITE





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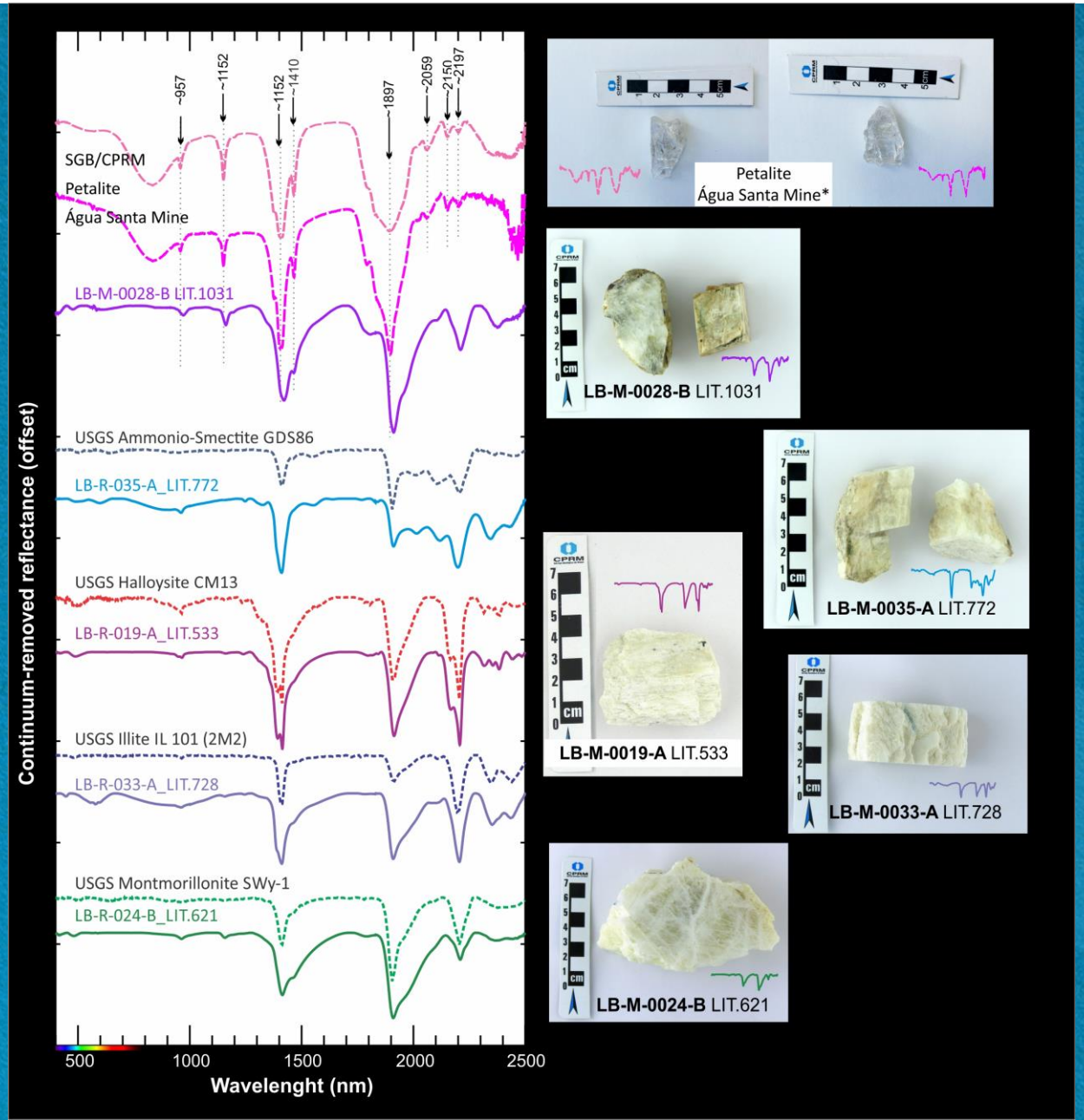
SPECTRAL LIBRARY OF Li-ORE MINERALS – MJR

PETALITE SPECTRAL SIGNATURES

* Acknowledgement to LF Mineração e Beneficiamento



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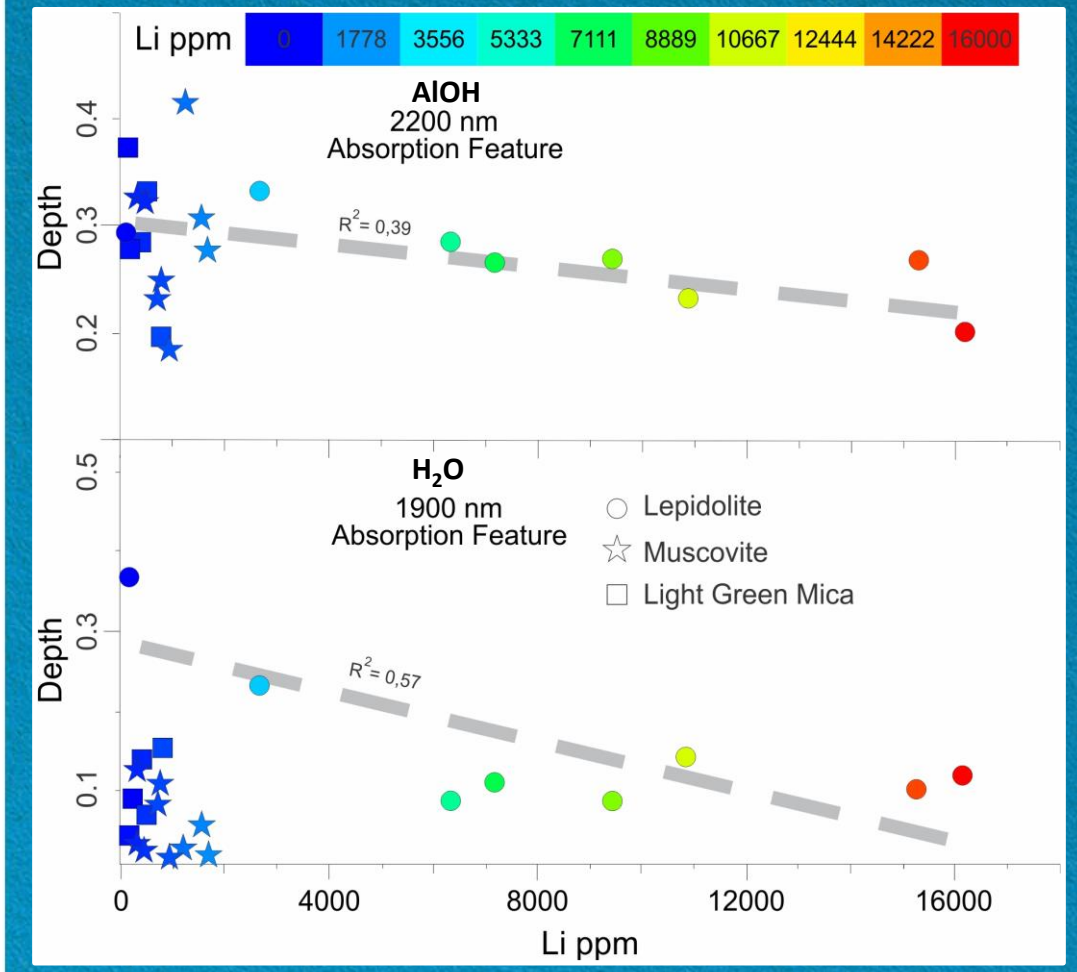
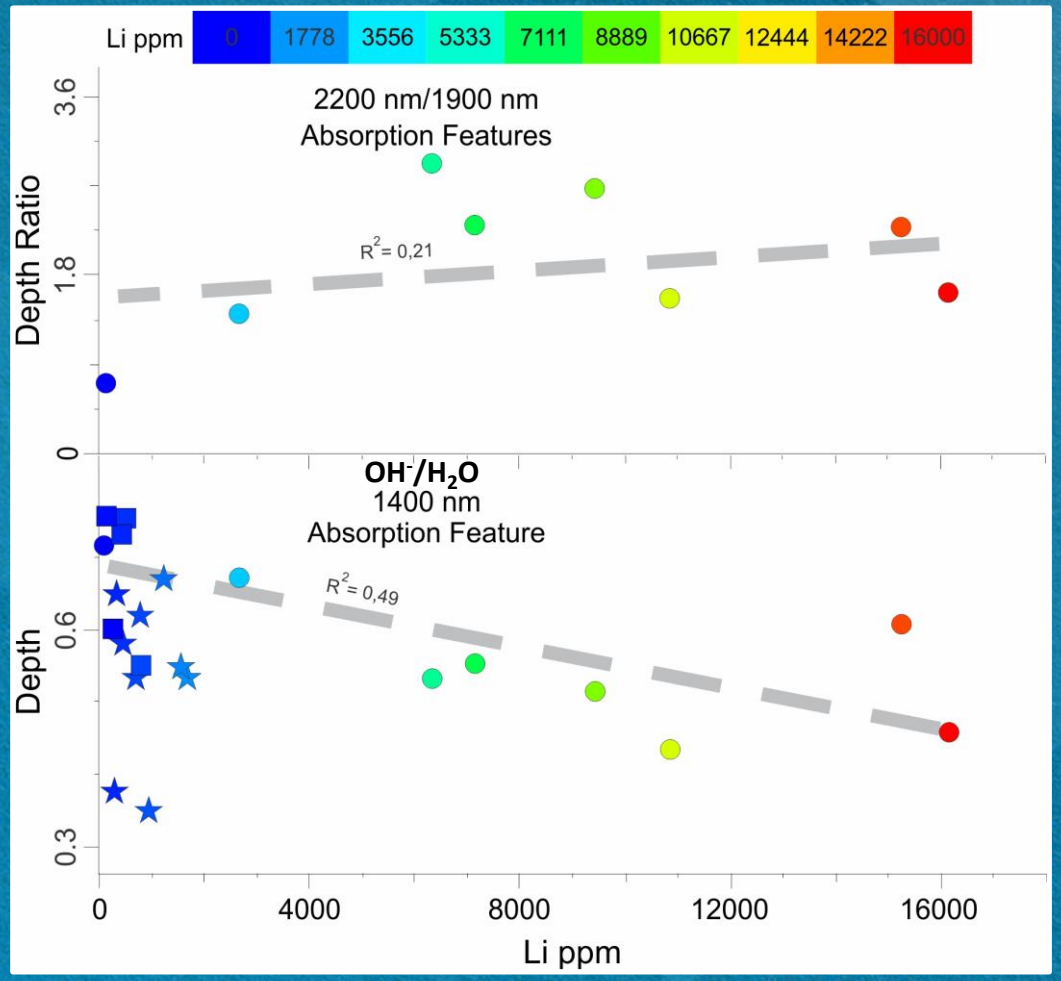
ANALYSIS of the SPECTRAL FEATURES OF Li-ORE MINERALS - BPP

MICAS Absorption Spectral Features Depth X Lithium Content

Lithium content variation with:

- depth variation of the main absorption features of micas (2200 nm, 1900 nm, 1400 nm);
- variation of the ratio between the depth of the features at 2200 nm and at 1900 nm for lepidolite





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SPECTRAL BEHAVIOUR OF Li-MINERALS

Amblygonite Main Absorption Features Depth X Lithium Content

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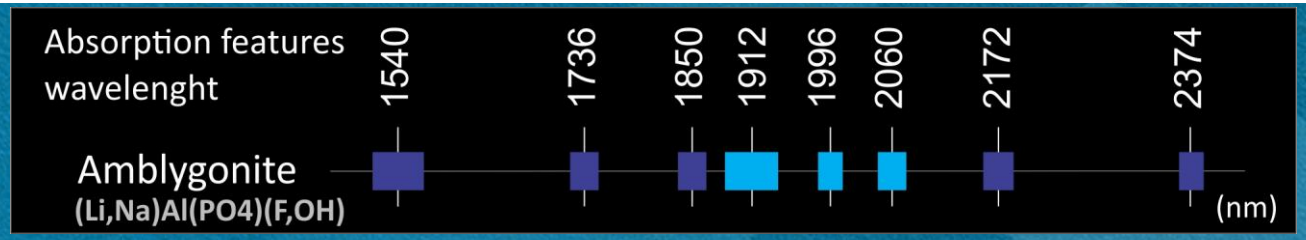

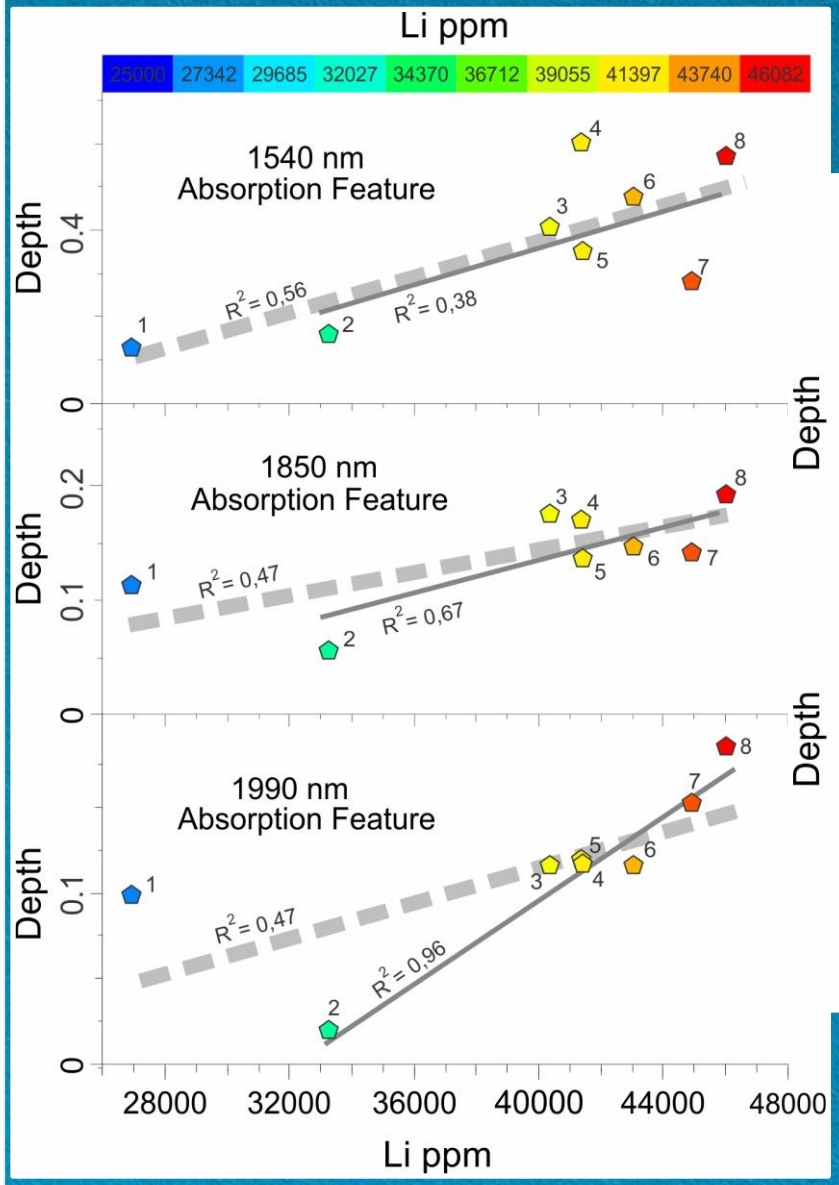

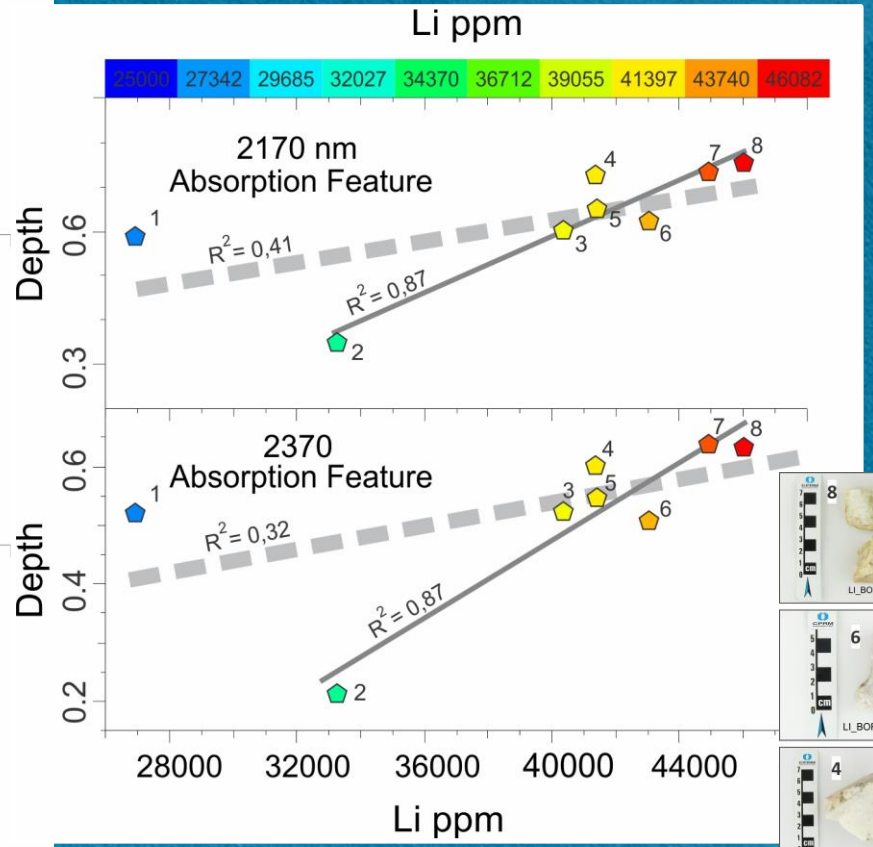

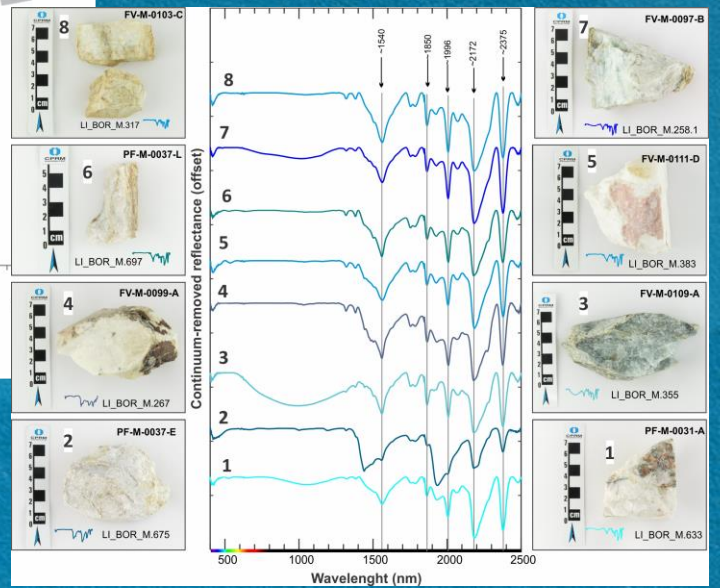

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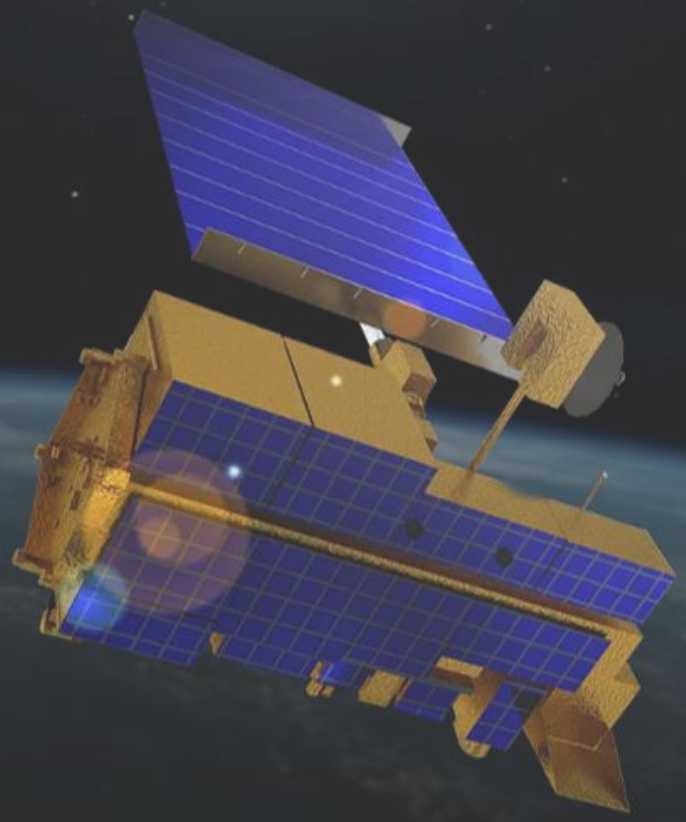
ASTER

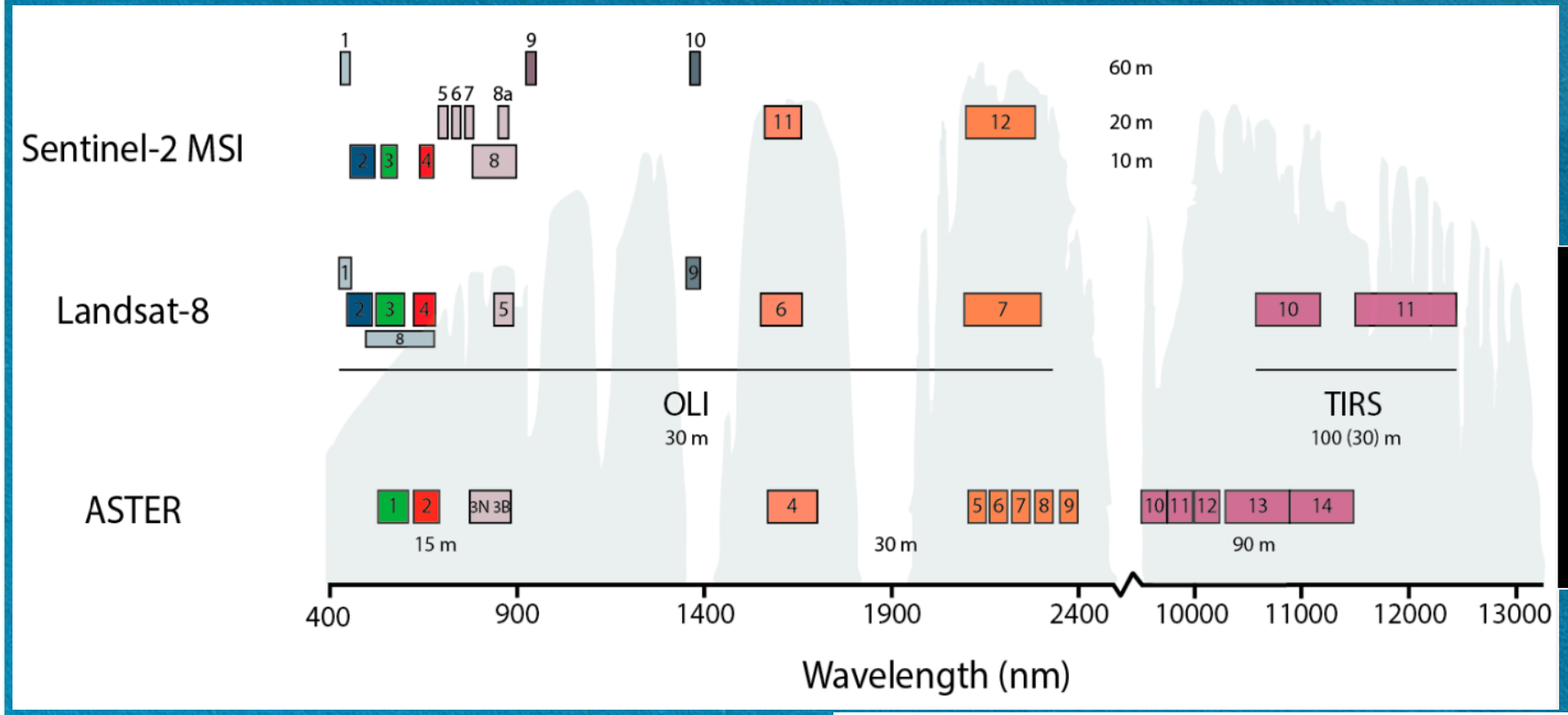
Designed to capture high-resolution images of Earth, the Advanced Spaceborne Thermal Emission and Reflection Radiometer, or ASTER, instrument is one of five instruments aboard NASA's Terra satellite.

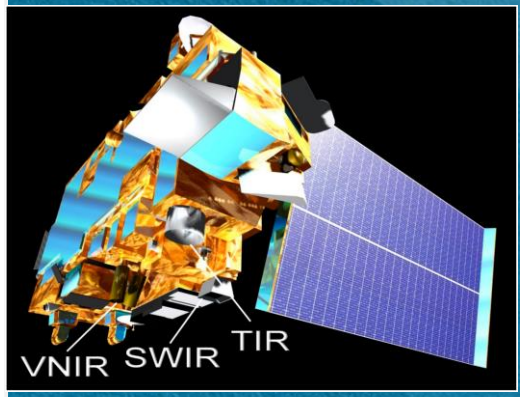
VISIT MISSION WEBSITE



MULTISPECTRAL REMOTE SENSING REFLECTANCE SPECTROSCOPY

Spectral Mapping applied to TERRA-ASTER sensor data





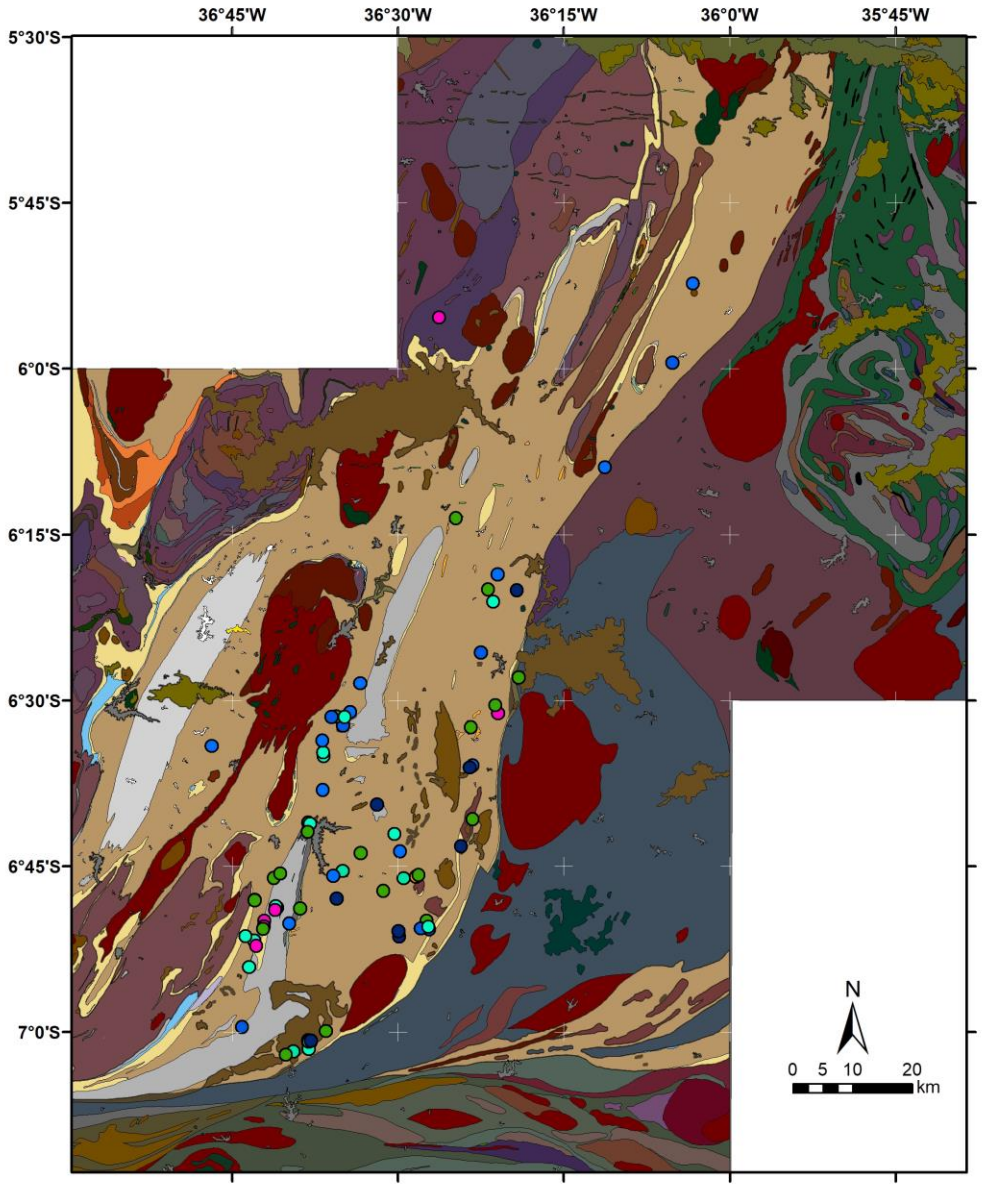
applied sciences
MDPI
Review

Detecting Lithium (Li) Mineralizations from Space: Current Research and Future Perspectives

Joana Cardoso-Fernandes [1,2,*], Ana C. Teodoro [1,2], Alexandre Lima [1,2], Mônica Perrotta [3] and Encarnación Roda-Robles [4]

MULTISPECTRAL REMOTE SENSING REFLECTANCE SPECTROSCOPY

ASSESSMENT OF LITHIUM POTENTIAL IN ASTER DATA- BPP



FAVORABLE GEOLOGY

Seridó Group (metasedimentary and metavolcanosedimentary units)

Li-Pegmatite Host Rocks

Legend

Lithium deposits

Predominant Li-ore minerals

- Amblygonite
- Spodumene
- Spodumene +/- Lepdolite +/- Amblygonite
- Lepidolite
- Lithiophilite/Triphilite

Seridó Group

NP3ss, ssc, af, cs — Seridó Formation: micaschists and garnet mica-schists (NP3ss); chlorite-sericite-biotite shales/ phyllites (NP3ssc); with levels of amphibolite (NP 3ssaf) and calcisilicate (NP3sscs).

NP3se, cg — Equador Formation: quartzites and muscovite quartzites (NP 3se), containing levels of conglomerates (NP 3secg).

sjug, sjuga, sjugx, sjugf, NP3sju, m, cs, u, a, f, q — Jucurutu Formation: predominant biotite-amphibole granoblastic gneisses (NP3sju), with levels/layers of marble (NP3sjum), calcsilicate rocks (NP3sjucs), metaultramafic (NP3sjuu), amphibolites (NP3sjua) and iron formations (NP3sjuf); quartz gneisses (NP3sjug); aluminous gneisses (NP3sjuga); muscovite-biotite gneisses/schists (NP3sjugx), feldspathic gneisses (NP3sjugf) and quartzites (NP3sjuq).

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MULTISPECTRAL REMOTE SENSING REFLECTANCE SPECTROSCOPY

ASSESSMENT OF LITHIUM POTENTIAL IN ASTER DATA- BPP

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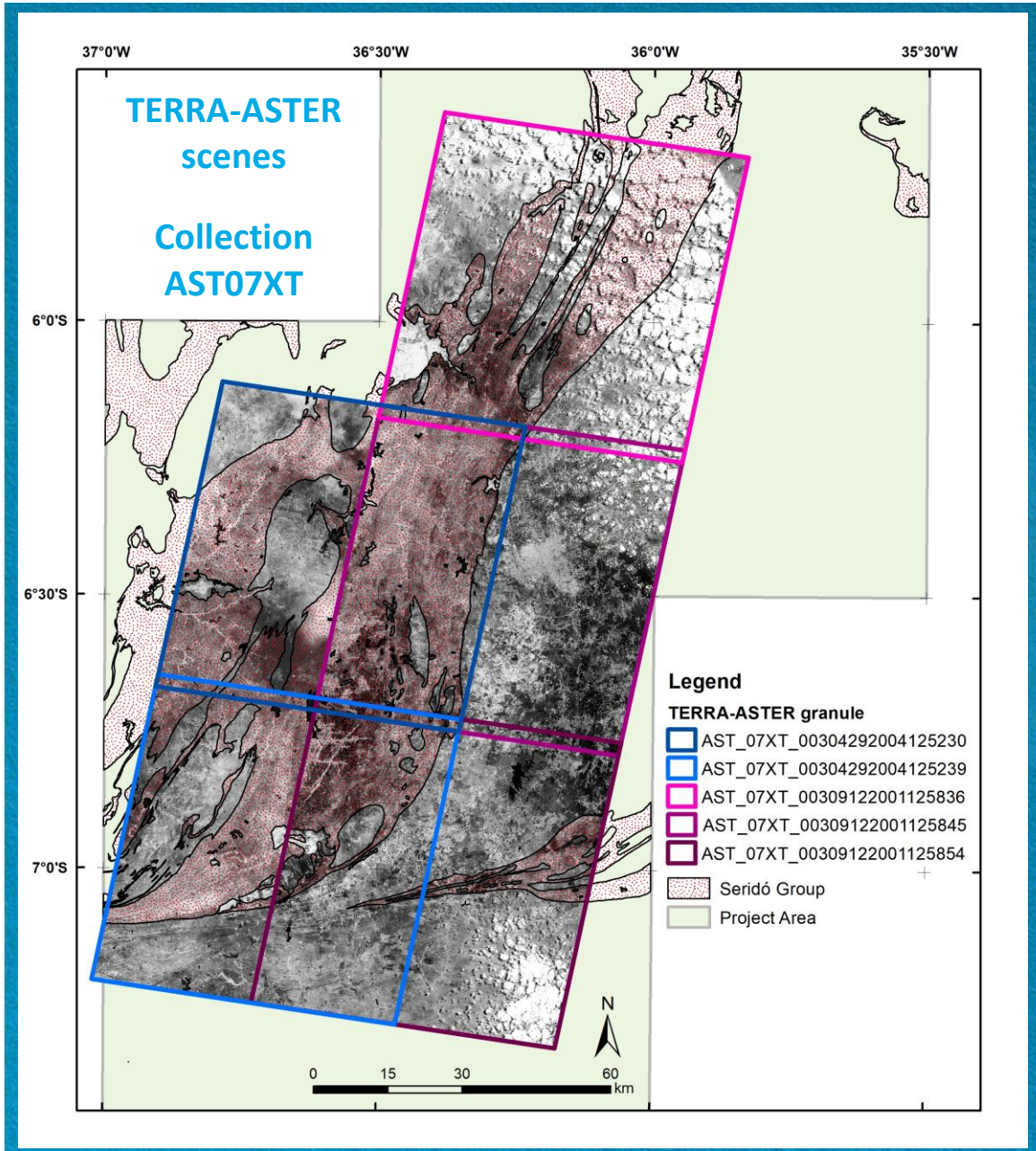

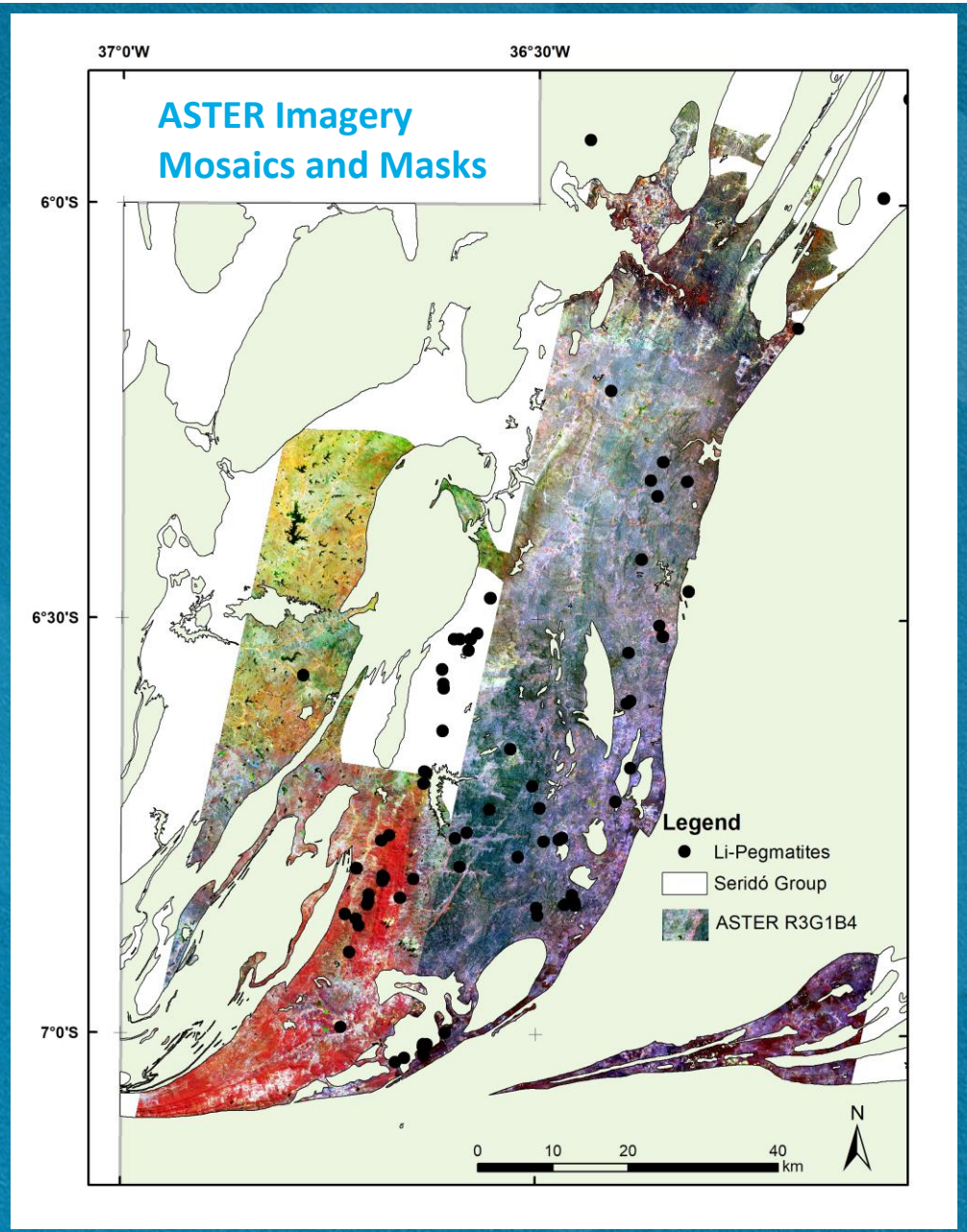

MULTISPECTRAL REMOTE SENSING REFLECTANCE - BPP

Ultraspectral (ASD - FieldSpec®3 Hi-Res) X Multispectral (TERRA – ASTER)

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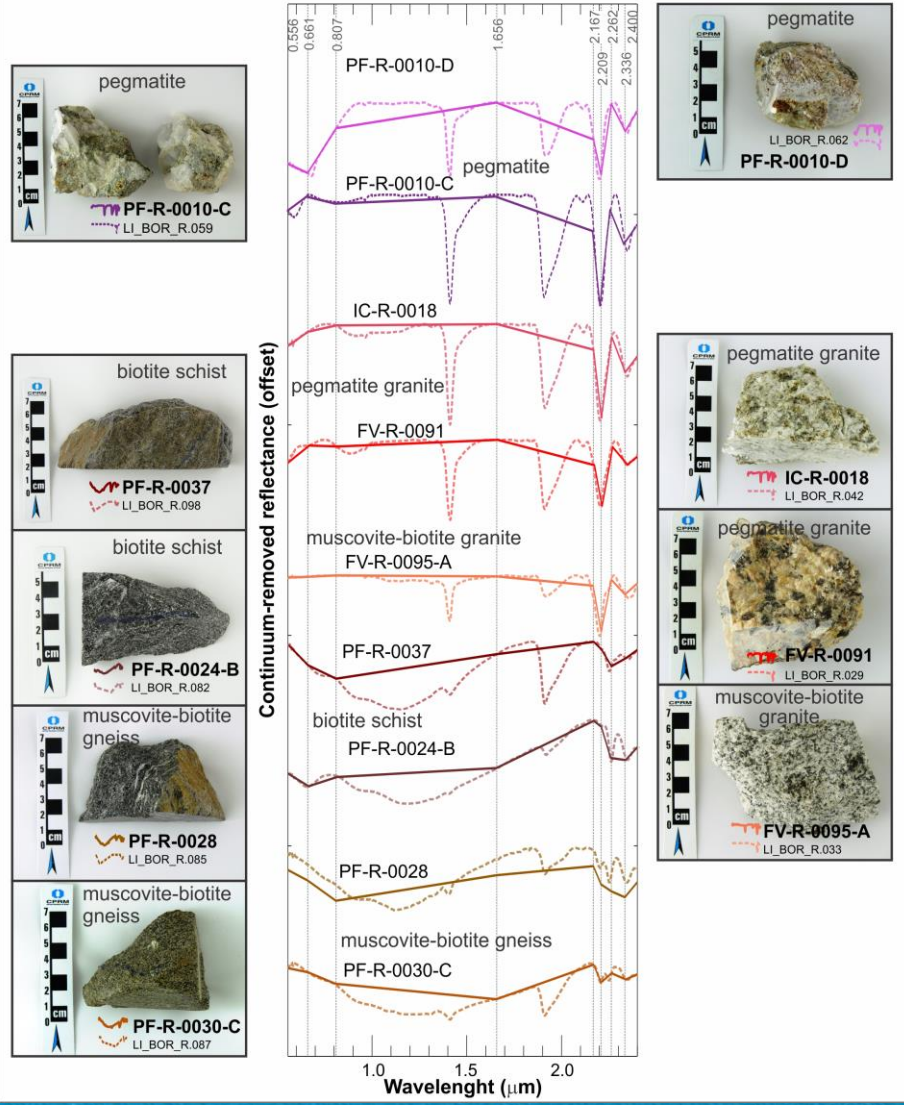
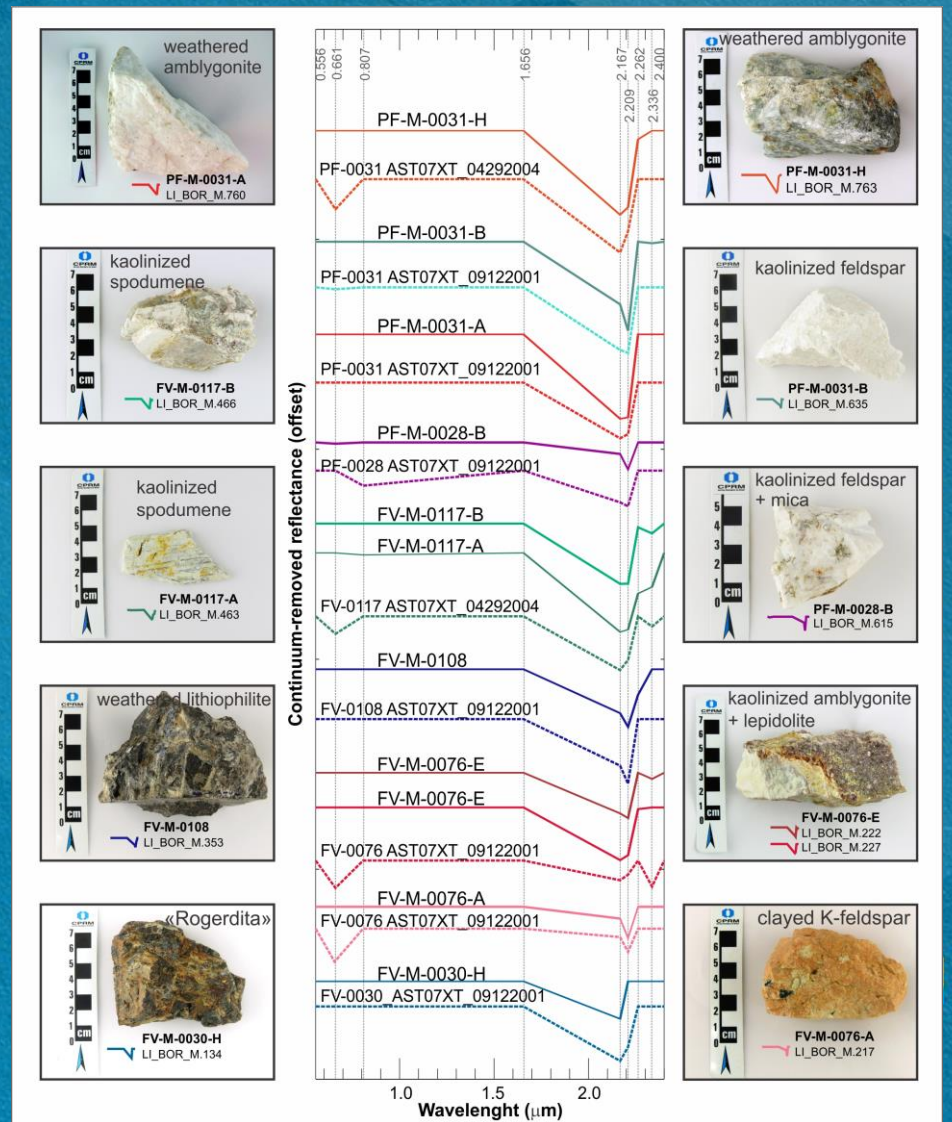
Discrimination of HOST AND COUNTRY ROCKS

Laboratory spectral signature resampled to ASTER spectral resolution



ALTERED Li-MINERALS AND PEGMATITE MINERALS

Signatures resampled to ASTER spectral resolution and signatures collected in correspondent pixels in ASTER data



MULTISPECTRAL REMOTE SENSING REFLECTANCE SPECTROSCOPY

SPECTRAL MAPPING – *Spectral Angle Mapper Classifier (SAM)* (Kruse et al., 1993)

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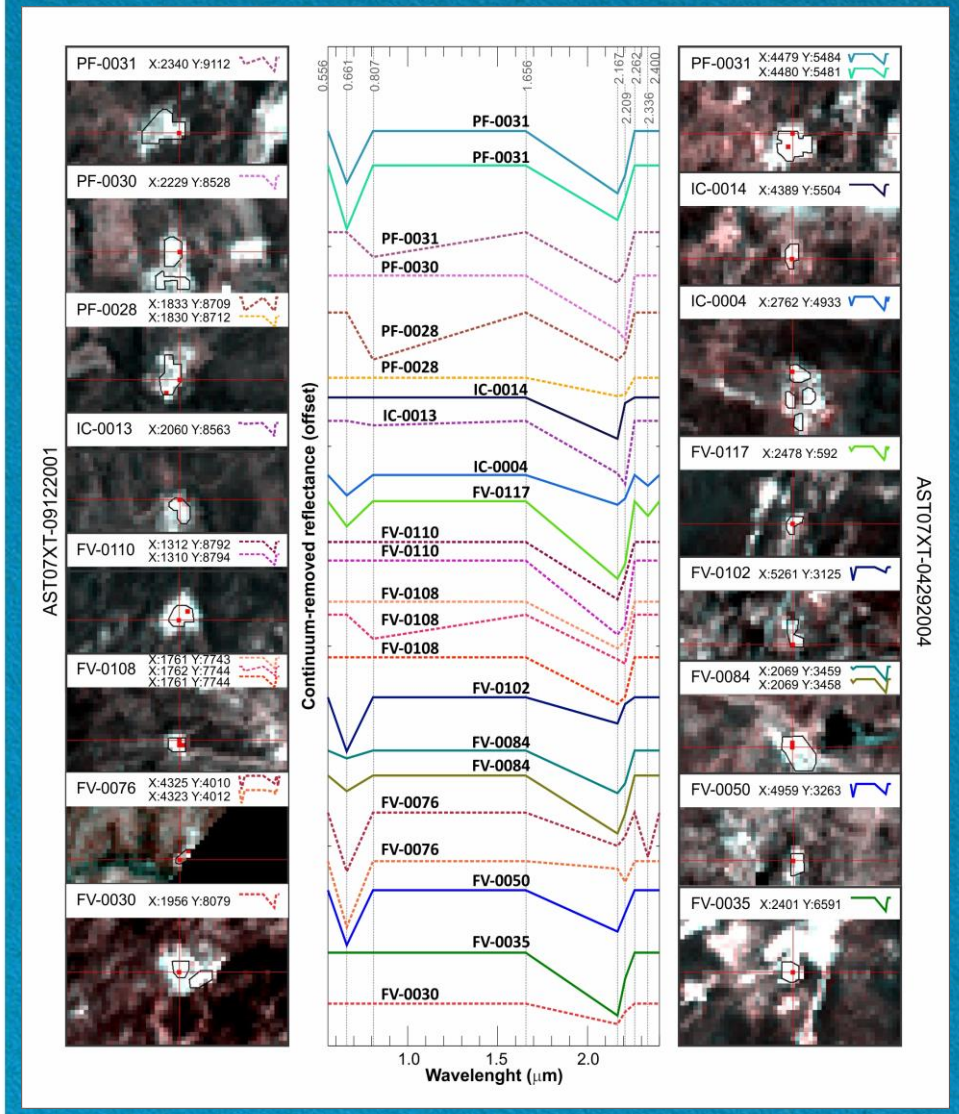
12/09/2001
13 pixels

Classification Reference Pixels: *Endmembers*

29/04/2004
10 pixels



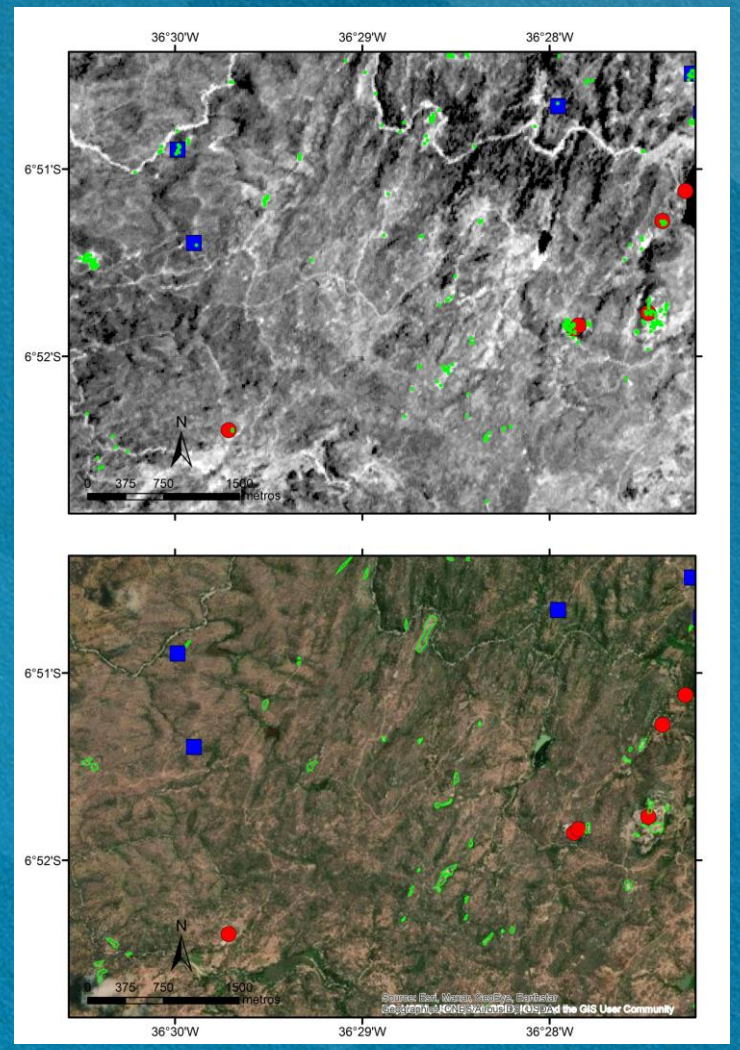
Numbers of Classification Process:

- **1002 pixels collected in both scenes, within 41 known deposits;**
- **Pixel Purity Index (PPI) *(Boardman et al., 1995)* calculation for the collected pixels;**
- **reduction to the final total of 23 reference pixels in 15 occurrences;**
- **Total number of pixels mapped / total pixels in scenes:**

  15,766 / *12,300,448* (12/09/2001)

  7,558 / *9,891,336* (29/04/2004)

- **Spatial matching with highest resolution image: reduction to 2,613 polygons of possible pegmatite bodies**



MULTISPECTRAL REMOTE SENSING REFLECTANCE SPECTROSCOPY

SPECTRAL MAPPING – *Spectral Angle Mapper Classifier (SAM)* - BPP

Summary of results	Li-pegmatite bodies visible in ASTER scenes	Final number of reference Li-pegmatite bodies	Number of Li-pegmatite bodies "non-reference" visible in ASTER scene	Number of Li-pegmatite bodies "non-reference" mapped by SAM classifier	Number of registered non-Li-pegmatite bodies visible in ASTER scene	Number of registered non-Li-pegmatite bodies mapped by SAM classifier
ASTER Scene 09122001	33	8	25	21	39	31
ASTER Scene 04292004	30	8	22	13	20	16
Total in scenes	*45*	*15*	*30*	*23*	*47*	*35*
Registered pegmatite bodies	71				103	
% nas cenas	63%			77%	45%	74%

Statistical results of the spectral classification by SAM (KRUSE et al., 1993) method for mapping pegmatite bodies, using the calculation of pixel purity indices - PPI (BOARDMAN *et al.*, 1995) for selection of reference pixel-signatures

ASSESSMENT OF LITHIUM POTENTIAL - BPP

Possible Pegmatite bodies mapped and compatibility with the favorability map

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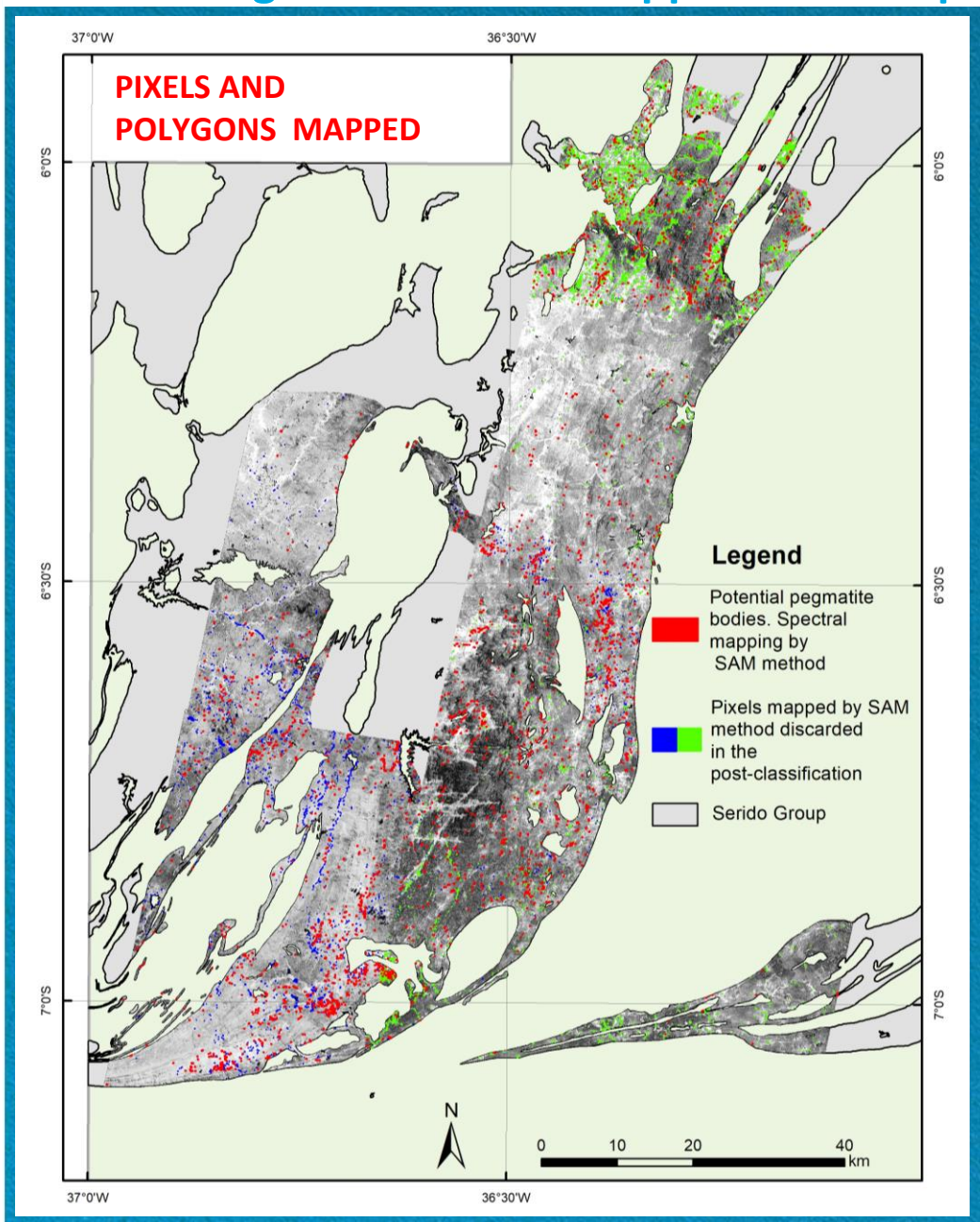

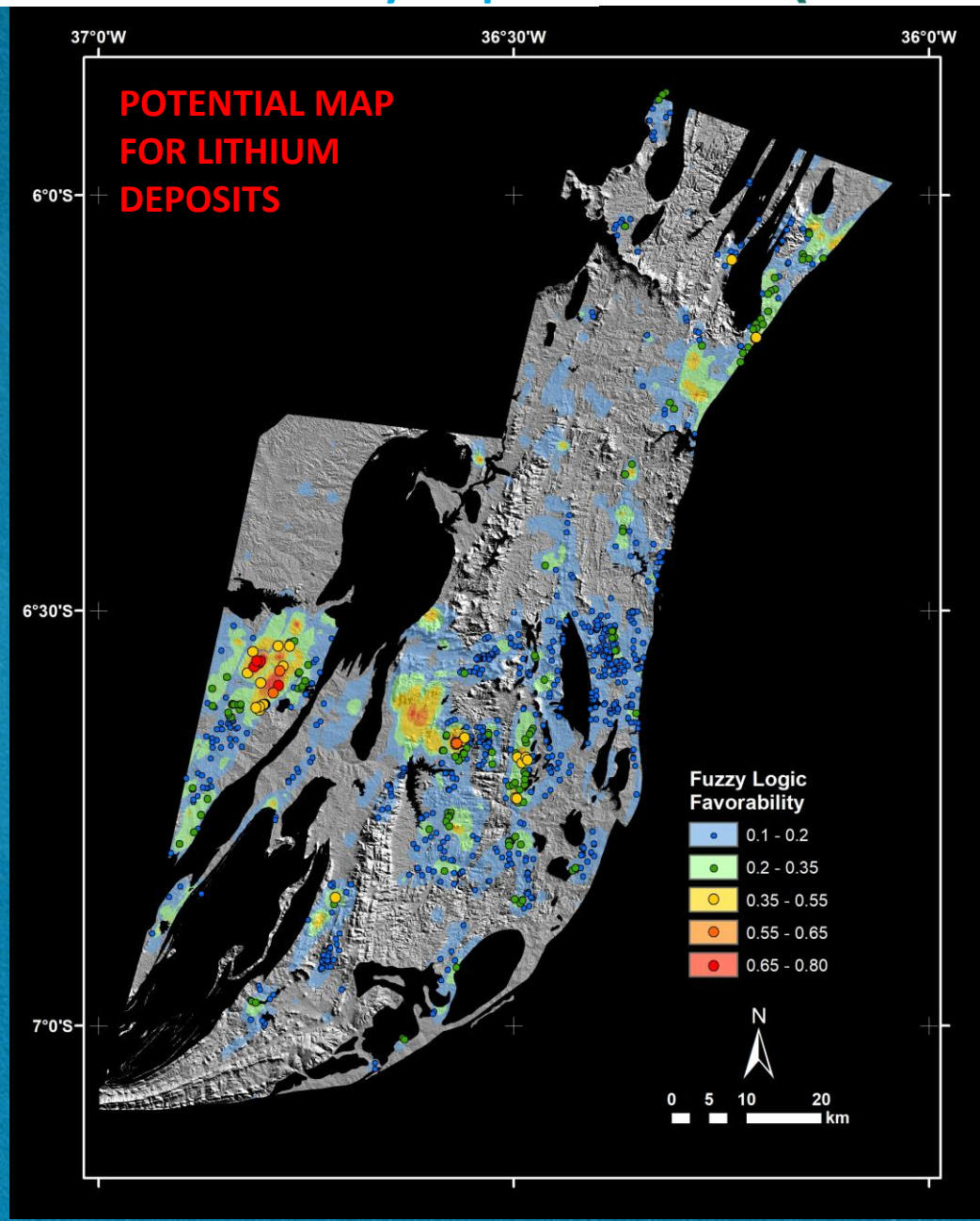

Thank You for your attention!

Mônica Mazzini Perrotta

Pesquisadora em Geociências

monica.perrotta@sgb.gov.br

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