TARGETING ALUNITE IN EPITHERMAL AND PORPHYRY COPPER DEPOSITS BY USING ASTER IMAGERY IN THE SIERRA MADRE OCCIDENTAL, MEXICO

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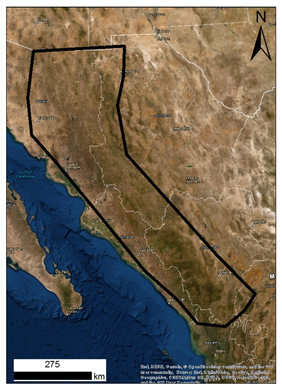
Introduction

Alunite is a sulfate mineral that is found in argillic alteration zones of porphyry and epithermal mineralization systems. Moreover, it is possible for use as a regional proxy to locate potential economic deposits. However, a weakness of most previous studies to map alunite with multispectral remote sensing data (e.g., Clark et al., 1993; Clark and Swayze, 1996; Rowan and Mars, 2003; Mars and Rowan, 2006) has been the inability to reliably distinguish alunite from clays, iron oxides and jarosite. This new technique can differentiate alunite from above minerals that could help in rugged areas such as the Sierra Madre Occidental.

Background

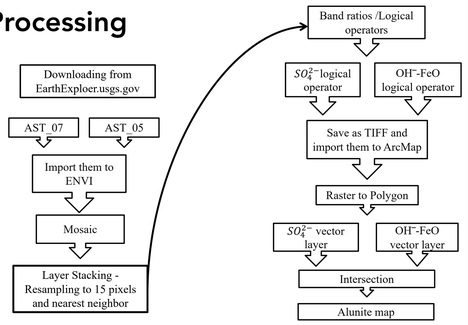
Porphyry copper and epithermal deposits are identified to be related with hydrothermal alteration, such as alunite.



Location:

The area of interested is covered most of Sierra Madre Occidental. It starts from the northern of the border of Mexico – USA and extends 1180 km south, and the width is from 150-300 km.

Processing



Logical operators

- $SO4^{2-}$ logical operator:

Mask for vegetation — Mask for dark pixels — Targeting 9-µm

$$\left(\left(\frac{band3}{band2}\right) \leq 1.35\right) \;\&\; (band4 > 260) \;\&\; \left(\left(\frac{band13}{band12}\right) > 1.08\right) \quad (1$$

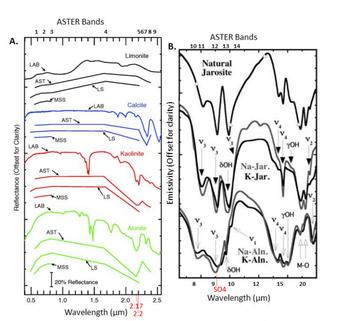
- OH-FeO logical operator:

Distinguish alunite from both iron oxides and sulfates

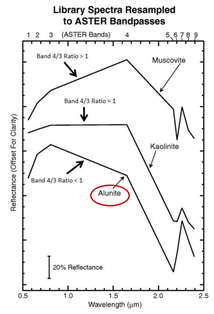
$$\left(\left(\frac{band3}{band2}\right) \leq 1.35\right) \;\&\; (band4 > 260) \;\&\; \left(\left(\frac{band4}{band3}\right) \leq 1\right)$$

Targeting 2.165 µm — Distinguish argillic from phyllic — Targeting 2.2 µm

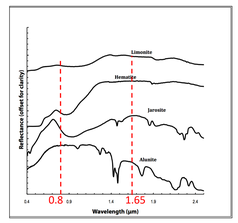
$$\&\left(\left(\frac{band4}{band5}\right) > 1.25\right) \;\&\; \left(\left(\frac{band5}{band6}\right) \leq 1.05\right) \;\&\; \left(\left(\frac{band7}{band6}\right) \geq 1.03\right) \quad (2).$$



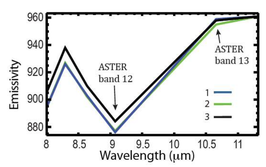
(A) laboratory reflectance spectra (LAB) of key minerals (Mars and Rowan, 2006). The doublet feature at 2.2 and 2.17 µm in alunite and kaolinite is used to distinguish it from other hydrous minerals. Alunite has deep absorption at 9 µm



The spectral slopes estimated using the ASTER band 4/3 ratio shows how a band threshold can be determined from ATER spectra. Alunite can be distinguish from kaolinite and muscovite

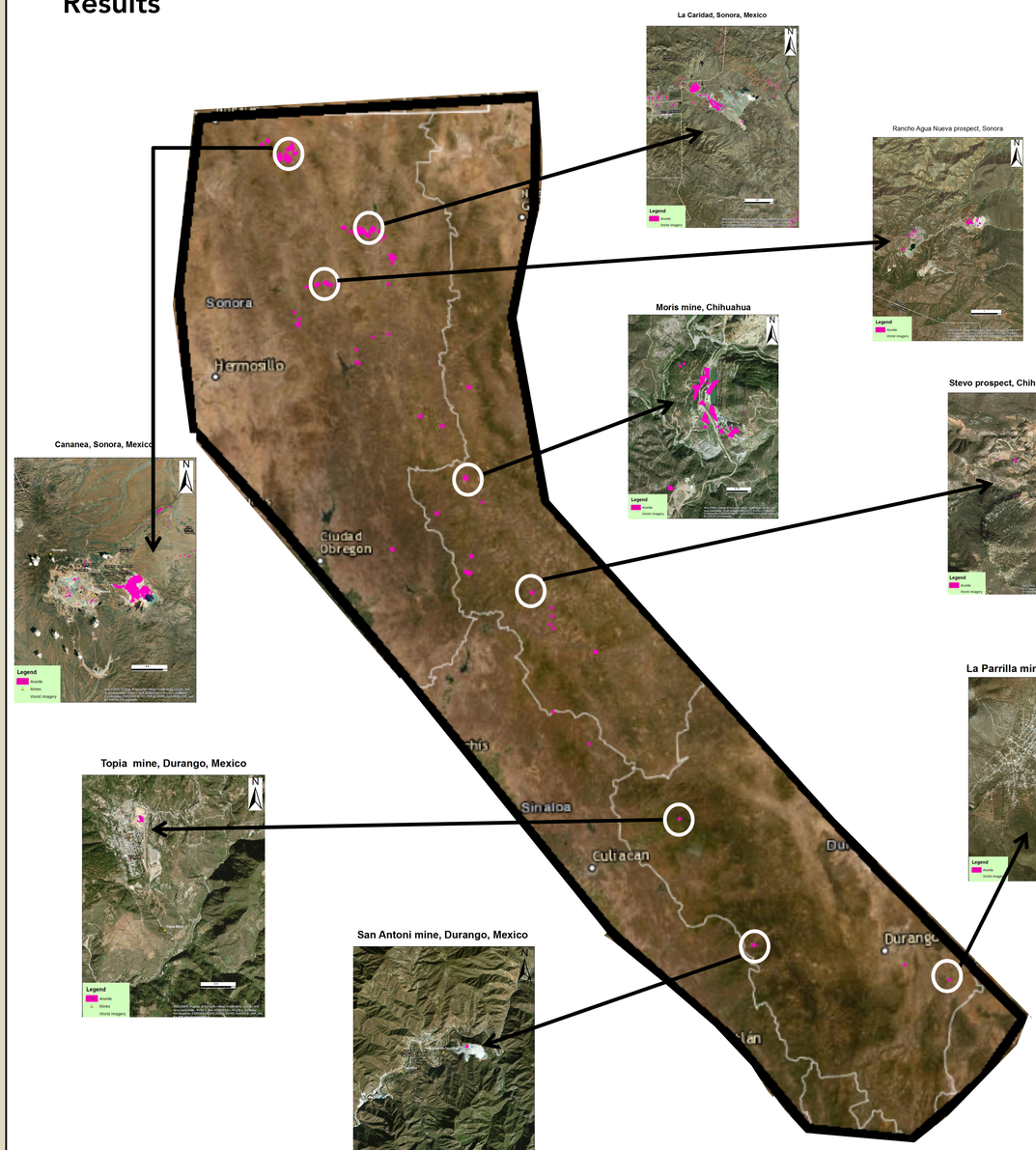


The red dished lines are showing the negative slope for the alunite between ~0.8 µm and ~1.65 µm (modified from Clark et al., 1993).

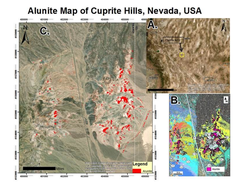


1, 2 and 3 are three locations of alunite at Cuprite hills from AVIRIS mineral map (Swayze et al., 2014). The emissivity in band 13 is 8% greater than band in 12.

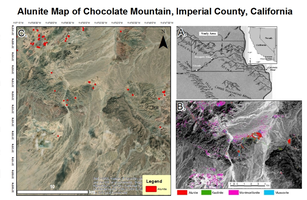
Results



Ground truth



Cuprite Hills, Nevada is a well-studied area that contains an abundance of hydrothermally-altered rocks such as alunite which is most important in this study (Ashley and Abram, 1980; Rowan and Mars, 2003; Mars and Rowan, 2006; Swayze et al., 2014).



Chocolate Mountain is located in the southeast Chocolate Mountains minerals area (approximately at 32.9°N, 115.1° W), in the eastern part of Imperial County, California, USA (Figure 10). It has been studded for mineral alteration such as alunite (Zhang, 2007), and is a significant gold province .

Conclusions

- Software has been developed to correctly identified alunite by remote sensing. This has been done in the Sierra Madre Occidental.
- 1140 polygons of alunite are found. Their size is vary from 1 to 8000 square meter.
- Several known mines have targeted for alunite such as Moris, Dolores, La Parrilla ,La Caridad San Antoni, Topia, Cananea, and Stavo.
- There are several target could be good for future exploration

Literature cited

Mars, J.C. and Rowan, L.C., 2006, Regional mapping of phyllic- and argillic-altered rocks in the Zagros magmatic arc, Iran, using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data and logical operator algorithms: Geosphere, v. 2, no. 3, p. 161-186, doi: 10.1130/GES00044.1.

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Further information

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