HYPERSPECTRAL REMOTE SENSING OF SERPENTINE ROCKS AND ASBESTOS BEARING ROOFING SLATE

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1. INTRODUCTION

Asbestos is a commercial term that represents several different silicate minerals which separate into long thin fibers. Asbestos has been used in numerous commercial applications due to its outstanding incombustible and insulating characteristics but causes fatal diseases such as lung cancer, asbestosis and malignant mesothelioma so strict regulations and controls for asbestos bearing rocks and products are necessary. However, untreated tailings bring those diseases have been left without any reclamation in several abandoned asbestos mine areas in Korea. In this study serpentine rocks and asbestos bearing roofing slate were spectrally analyzes and roofing slate was detected on EO-1 Hyperion imagery.

2. DESCRIPTION OF SAMPLES

Asbestos can be divided into two major classes of minerals, serpentines and amphiboles (table 1). Chrysotile is the only asbestos mineral of the serpentine group and has been the most widely used commercially.

Table 1 Mineralogical description of asbestos.

class	mineral	chemical formula
serpentine	chrysotile	$Mg_3Si_2O_5(OH)_4$
amphiboles	actinolite	$Ca_2(Mg, Fe)_5Si_8O_{22}(OH)_2$
	anthophyllite	$Mg_7Si_8O_{22}(OH)_2$
	amosite (grunerite)	$(Mg, Fe^{2+})_7Si_8O_{22}(OH)_2$
	crocidolite (riebeckite)	$Na_2(Mg, Fe)_5Si_8O_{22}(OH)_2$
	tremolite	$Ca_2Mg_5Si_8O_{22}(OH)_2$

Serpentine rocks containing asbestos were collected in one working serpentine mine, four abandoned asbestos mines and roofing slate was sampled in rural area (figure 1). The major mineral constituents of samples were analyzed using X-ray diffraction method (table 2).

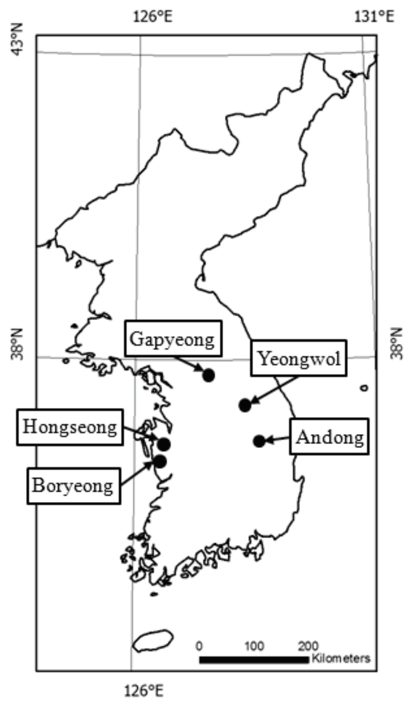


Figure 1 Location of sampling sites in Korea.

Table 2 Major mineral constituents of serpentine rocks and roofing slate.

sample	site description	major constituent minerals
S-ADP	working serpentine mine in Andong	serpentine, calcite, chlorite
S-ADB	working serpentine mine in Andong	serpentine, calcite, pyroxene, dolomite, magnetite, quartz
S-BR	abandoned mine in Boryeong	amphibole, talc, chlorite, serpentine
S-GP	abandoned mine in Gapyeong	serpentine, pyroxene, olivine, magnetite
S-HS	abandoned mine in Hongseong	talc, amphibole, serpentine, chlorite
S-YW	abandoned mine in Yeongwol	dolomite, amphibole, chlorite
slate	rural area in Boryeong	calcite, serpentine, chlorite, micas, wollastonite, gypsum, feldspar

3. EXPERIMENTAL PROCESS OF HYPERSPECTRAL REMOTE SENSING

Spectral reflectance curves of whole samples were measured with Fieldspec®3 spectrometer of ASD Inc. from 350nm to 2,500nm wavelength. Spectral angle mapping method [1] was adopted to compare spectral angles between Hyperion pixels in parameter vector space and reference pixels consisted of roofing slate.

4. RESULTS

Two diagnostic asbestos absorption features with wavelength range of 1,380 - 1,400 nm (1st OH overtone) and 2,320 - 2,340 nm (Mg-OH combination band) were extracted from reflectances of samples and this features show identical result of previous researches [2][3][4](Bassani et al., 2007; Clark, 1999; Swayze, 2009).

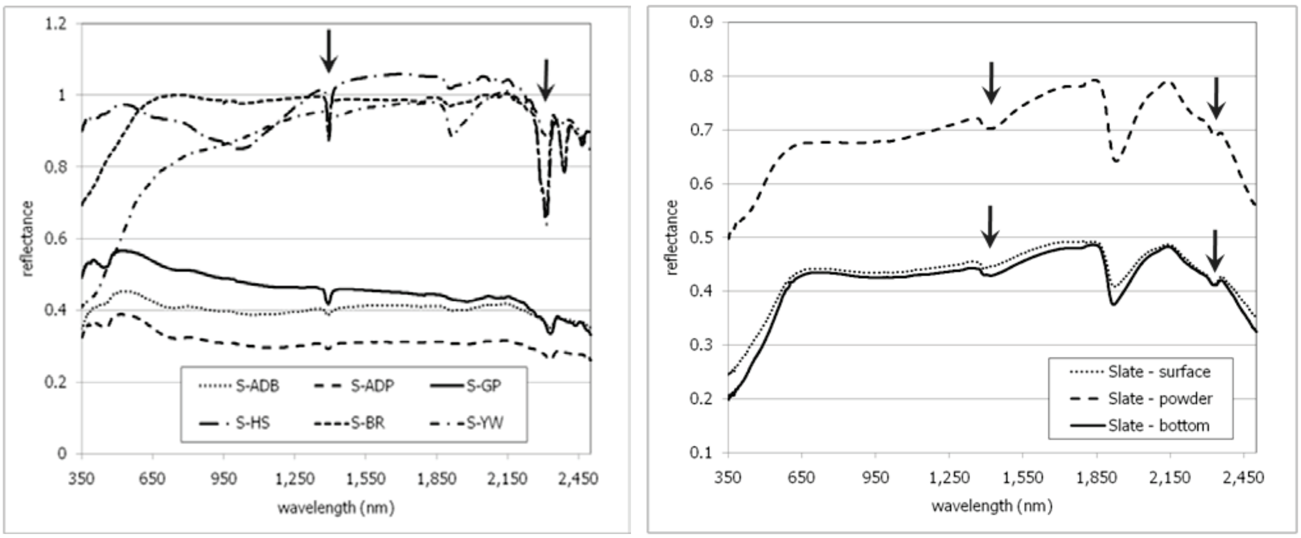


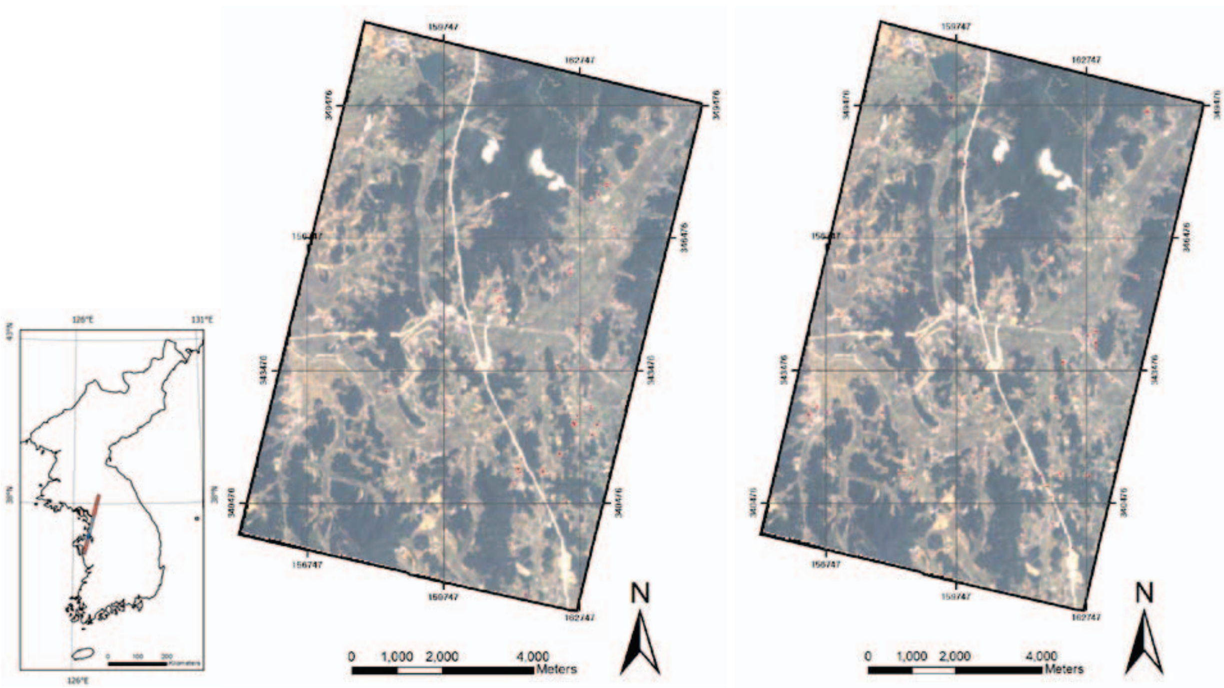
Figure 2 Spectral reflectances of serpentine rocks and roofing slate.

The roofing slate was detected and mapped using EO-1 Hyperion imagery in Hongseong area, Korea. The Hyperion imagery was analyzed with the two cases of spectral range and parameter of matching method (table 3).

Table 3 Hyperspectral analysis of roofing slate

	case I	case II
spectral range	VNIR&SWIR (448.8 ~ 2367.2 nm)	feature subset (2,153.3 ~ 2,355.2 nm)
matching method	spectral angle mapping (0.035)	spectral angle mapping (0.02)

The mapping results (figure 3) show relatively higher sensitivity in case II and more accurate result in case I. The user's accuracy was calculated using high resolution aerial photography and in-situ investigation and the accuracy of case I is about 30 % and case II is more than 60 %. The accuracies showed uniform trends with decreasing of spectral angles in each case.



(a) (b) (c)

Figure 3 Distribution of roofing slate (red pixels) in Hongseong area, Korea.

(a) location of imagery, (b) mapping result of case I, (c) mapping result of case II

5. CONCLUSION

In this study, serpentine rocks containing asbestos sampled from five abandoned asbestos mines and one roofing slate sample were analyzed with XRD and spectrometer. The diagnostic absorption feature of asbestos was identified in the vicinity of 1,380 - 1,400 nm (1st OH overtone) and 2,320 - 2,340 nm (Mg-OH combination band) wavelength. The roofing slates were mapped using EO-1 Hyperion imagery and spectral angle mapping method. More accurate mapping result was carried out in the case of using whole spectral range than the case of using feature subset.

11. REFERENCES

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