Near-IR Reflectance Properties of Type 3 Ordinary Chondrites

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Introduction:

Type 3 ordinary chondrites are the most primitive members of the largest meteorite class. "Most primitive" mean least altered since formation.

There are three important minerals: olivine ($(Fe,Mg)_2SiO_4$), pyroxene ($(Fe,Mg)SiO_3$), and the pyroxene in two crystal forms, orthorhombic and monoclinic. These are referred to as orthopyroxene (OPX) and clinopyroxene (CPX).

The type 3 ordinary chondrites are subdivided into type 3.0 to 3.9 reflecting the amount of metamorphism on their parent asteroid. (Metamorphism is heating without melting).

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Experimental:

- IR Data from RELAB database which is funded by NASA was downloaded for type 3 ordinary chondrites in order to graph the data and then determine the percent of CPX and OPX. Also, courtesy of NASA, eight additional samples were obtained from Johnson Space Center.
- The IR data was graphed and by just simply using the eye and ruler the percentage was determined by comparing this result to already graphed data by other scientists [1].

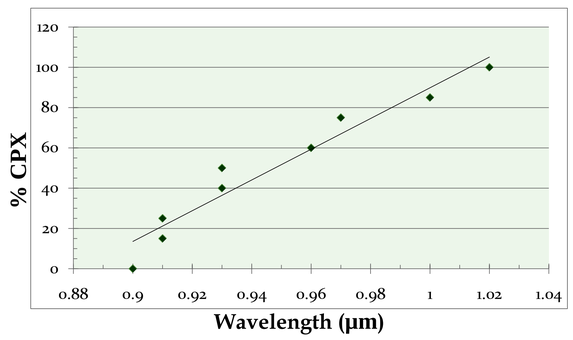

Figure 1: Graph for the 1µm region with calibration curve drawn across the graph.

- After obtaining percent CPX by using what looks like an easy technique, a more sophisticated and accurate method was utilized to obtain percent CPX. The Modified Gaussian Model (MGM) [2] software that has the capabilities of deeply analyzing an IR graph gives a band strength that will lead to the calculation of percentage.

$$CBSR^* = \frac{\text{Band Strength OPX component}}{\text{Band Strength CPX component}} \quad .....(1)$$

*CBSR- Component Band Strength Ratio [3]

Results:

Results for the type 3 (3.0-3.9) ordinary chondrites in the graphs is shown below in Table 1. The band dip for 1µm region ranged from 0.88 to 0.94µm. While for the 2 µm region varied from 1.87 to 2.05 µm.

Table 1: CPX percentages for type 3 chondrites determined by visual inspection of the spectra.

Name	Class	N	1 µm	% CPX	2 µm	% CPX
Dimmit	H3.7	1	0.94	44	1.93	55
Acfer 111	H3	1	0.92	28	1.90	43
Y-74191	L3.7	5	0.90	14	1.90	43
ALHA77214	L3.4	2	0.92	28	1.94	58
Mezo-Madaras	L3.7	4	0.92	28	2.00	71
Hedjaz	L3.7	2	0.93	36	1.97	67
Krymka	LL3.1	2	0.94	44	1.95	62
Hallingeberg	L3.4	1	0.94	44	2.01	70
Moorabie	L3.8	1	0.91	21	2.00	70
Bishunpur	LL3.1	1	0.93	36	bd	bd
Dhajala	H3.8	1	0.90	14	1.92	52
Hedjaz	L3.7	1	0.91	21	1.89	36
Suwahib (Buwah)	H3.8	1	0.92	28	1.92	52
Khohar	L3.6	1	0.92	28	1.96	64
GRO95505	3.40	1	0.93	36	1.94	58
GRO95504	3.50	1	0.91	21	1.87	24
ALHA77216	3.7-3.9	1	0.88	bd	1.90	43
GRO06054	3.60	1	0.94	44	1.98	69

N, number of replicate samples.
bd, below detection.

In theory, as one goes from type 3.0 to 3.9 ordinary chondrites, the amount of CPX should decrease relative to the OPX content. Likewise, for the results obtained from the research, the same rules should apply. But the expected trend was not seen in our results. The data in table 1 was graphed so that it can easily be interpreted as shown below in Figures 2 and 3.

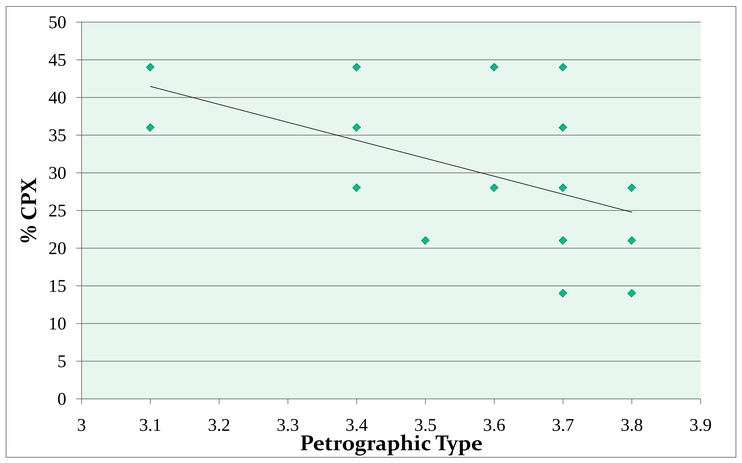

Figure 2: Graphed data from table 1 for the 1 µm region with calibration curve drawn across the graph.

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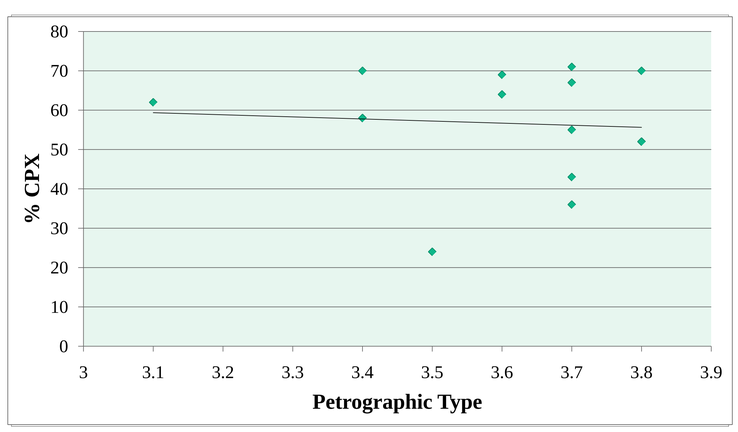

Figure 3: Graphed data from table 1 for the 2 µm region.

The direct results of the MGM software were significant. For example, for Mezo–Madaras, the percentage result from Table 1 was 28% for 1µm and 71% for the 2µm regions. This was different from MGM result of 34.5% for 1 µm and 52% for 2µm regions. This was common for most of the samples.

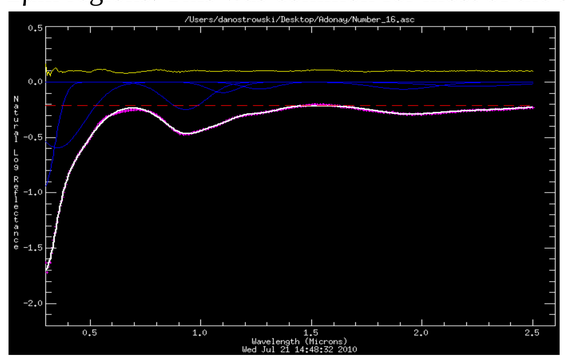

Figure 4: Fitted MGM graph of Mezo-Madaras.

Conclusion and Future Work:

It is possible to determine the amount of CPX/OPX in a particular sample by just looking at near IR graphs but to some certain degree of accuracy. To get a more reliable or accurate result a more sophisticated procedure has to be utilized, like the MGM software.

In the future, more samples are going to be analyzed by using the MGM software.

We will run IR- spectrum of Fayetteville meteorites and then use the MGM to determine the specific location the meteorites came from.

References: [1] Sunshine, J., et at. *Journal of Geophysical Research* 98, no. E5 (1993): 9075-9087. [2] Sunshine, J., et at. *Journal of Geophysical Research* 95, no. B5 (1993): 6960-6965. [3] Sunshine, J., et at. *Journal of Geophysical Research* 98, no. E5 (1993): 9080.

Acknowledgements:

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