ELECTRON-MICROPROBE AND CATHODOLUMINESCENCE STUDY OF GLASSES IN TYPE 3 ORDINARY CHONDRITES: RELEVANCE TO METAMORPHISM AND AQUEOUS ALTERATION. John M. DeHart*, Gary E. Lofgren+ and Derek W.G. Sears*, *Department of Chemistry, University of Arkansas, Fayetteville, AR 72701. +Sn4, NASA Johnson Space Center, Houston, TX 77058.

INTRODUCTION: The thermoluminescence (TL) and cathodoluminescence (CL) properties of ordinary chondrites are a sensitive indicator of the degree of thermal metamorphism (1,2). For types >3.3, trends involving TL sensitivity, peak temperature and width reflect the formation of the principle phosphor, feldspar (2), through devitrification (3). At lower metamorphic levels, the TL trends break down and other phosphors become important; the process of aqueous alteration may have been involved (4,5). In order to explore the luminescence properties of primitive ordinary chondrites and understand their systematic variations throughout the type, we have undertaken an electron-microprobe study of the major CL phosphors in Semarkona (3.0) and Krymka (3.1). Here we report our results for the chondrule glasses.

OBSERVATIONS: Chondrule glasses in Semarkona were dominated by two different CL responses, yellow (32% of chondrules and fragments >.3 mm), and blue (21%). A large proportion (38%) had no luminescent response (we call these dark glasses). The glasses in Krymka were more varied in their CL response, blue/white luminescent glasses (57%) and dark glasses (31%) were dominant; very few glasses with red (7%), violet (1%) or yellow (4%) CL were observed. Significant compositional differences between glasses of different CL color were found (Table 1), and blue glasses of Semarkona were compositionally distinct from those of Krymka. A plot of weight percent Na_2O vs. CaO (Fig. 1) indicates that most of the yellow and blue luminescent glasses tend to lie along a plagioclase-like mixing line (a line fitted to the data by least squares method for all blue and yellow luminescent glasses results in a correlation coefficient of -.89 and a slope of -1.70). Dark glasses and a single red glass from a chondrule in Krymka were poor in CaO and Na_2O. These compositional differences are reflected in the feldspar content contained in the CIPW norms calculated for each, with blue glasses in Semarkona having a predominant albite component, yellow glasses have a predominant anorthite component, and dark glasses have a significantly higher orthoclase component. A single violet glass in Krymka was extremely high in normative anorthite, while a single yellow glass plotted well off the mixing line in Fig. 1. Krymka blue glasses lie along the entire length of the mixing line.

INTERPRETATIONS: It is clear from the present data that the CL and TL are produced essentially by glasses of plagioclase composition. This is consistent with other data on the metamorphism-TL relationship which is associated with blue luminescing plagioclase; in equilibrated chondrites the plagioclase is oligoclase (6). That calcic plagioclase-like glasses have yellow CL in Semarkona, but not Krymka, provides a clue as to the processes which distinguish the two meteorites. One possibility is that calcic plagioclase contained in the glasses are attacked preferentially by water (7), another is that they devitrify more readily than sodic glasses (8), providing a pathway for reaction.

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This research is supported by NASA grants NAG 9-81 and NGT-50064.

Table 1. Average glass analyses in weight percent concentration

Meteorite	Color	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	Cr2O3	P2O5	Total	CIPW Norm Plagioclase Content Ab	An	Or	Total
Semarkona	Yellow	54.34	0.46	2.26	1.56	0.28	3.60	13.68	2.17	0.14	0.27	0.18	98.95	18.40	50.58	0.81	69.79
Krymka	Yellow	47.66	1.10	9.32	1.79	0.13	18.94	9.32	0.19	0.02	0.24	0.37	98.19	1.61	24.52	0.12	26.25
Semarkona	Blue	63.40	0.34	19.34	3.11	0.13	1.43	4.56	7.17	0.18	0.05	0.66	100.35	60.62	17.01	0.92	78.54
Krymka	Blue	54.51	0.33	24.16	2.40	0.16	3.14	10.03	4.54	0.08	0.15	0.16	99.66	38.39	41.80	0.50	80.68
Semarkona	Dark	71.72	0.46	13.59	5.44	0.21	1.50	1.97	1.53	0.91	0.07	0.39	97.79	12.91	7.27	5.37	25.56
Krymka	Dark	67.88	0.52	15.76	5.95	0.18	2.22	1.52	4.75	1.68	0.07	0.08	100.62	40.21	6.42	9.93	56.56
Krymka	Red	54.96	0.45	6.87	0.71	0.11	32.34	3.74	0.22	0.02	0.63	0.06	100.11	1.86	17.70	0.12	19.68
Krymka	Violet	47.18	0.03	32.37	1.23	0.01	0.51	17.29	1.82	0.00	0.00	0.01	100.45	15.40	80.16	0.00	95.56
Semarkona	Red	56.56	0.51	17.78	4.34	0.20	3.75	12.75	1.00	0.03	0.53	0.18	97.62	8.42	43.96	0.18	52.56

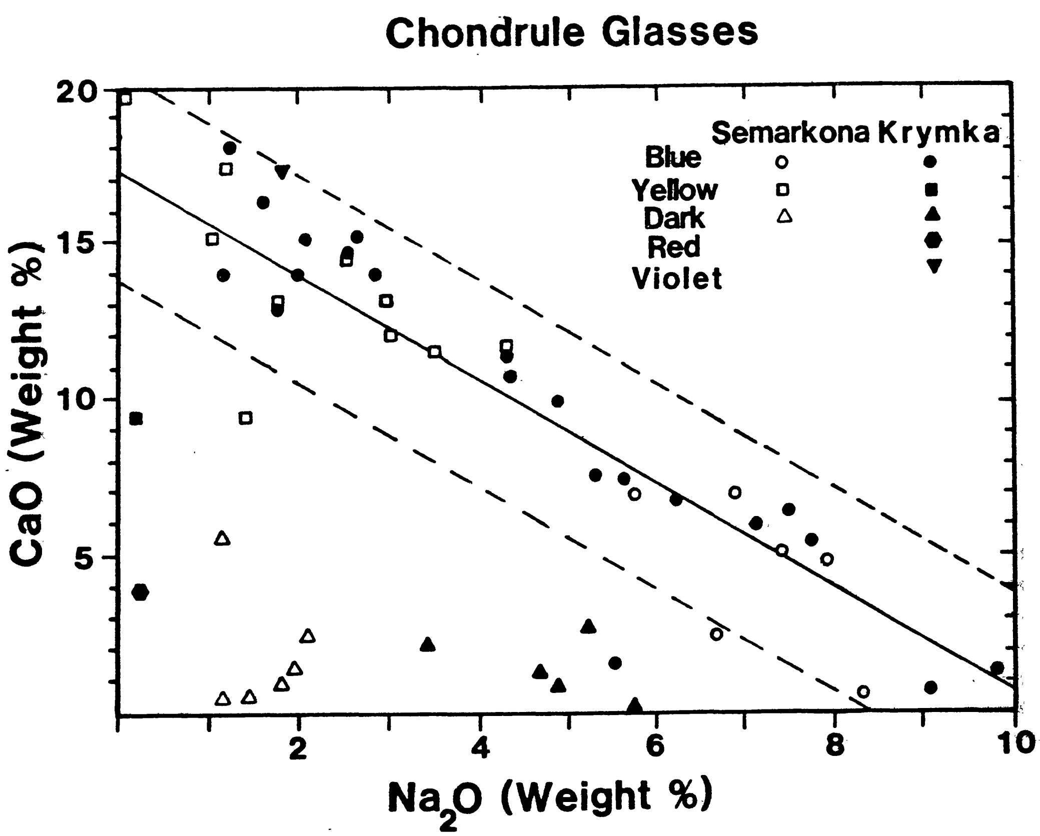

Fig. 1. CaO vs. Na2O in glasses from Semarkona (3.0) and Krymka (3.1). The diagonal represents a plagioclase-like series. The colors listed refer to cathodoluminescent colors.