THE 52-COLOR ASTEROID SURVEY: FINAL RESULTS AND INTERPRETATION.

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Motivation and philosophy of the survey: From November 1983 to April 1987 we conducted the first extensive survey of the spectral refectance curves of asteroids in the wavelength range 0.8μm to 2.5μm. Earlier work on selected bright asteroids had demonstrated that this wavelength range contained considerable mineralogical information which was not available from measurements in the photovisual (0.3-1.1μm) wavelength range (1,2). Advances in the technology of IR astronomy suggested that it would be possible to obtain a large, consistently reliable spectral data base in the IR by means of a concentrated, long term program analogous to the 24-color (3) and 8-color (4) photovisual asteroid surveys. Initially we concentrated on obtaining spectra of several represenative examples of each of the taxomonic types of D. J. Tholen (5). Later observations concentrated on exploring the very varied S-type population, members of particular dynamical families, and selected bright Earth-approachers.

Observing techniques and equipment: The data was obtained at the 3-meter reflector of the NASA Infrared Telescope Facility. The facility detector systems "RC1" and "RC2" were employed, but with a nonstandard circular-variable-bandpass interference filter originally designed for observation of the Uranian satellites (6). By rotating the filter, photometry was obtained in 52 bandpasses between 0.8μm and 2.5μm wavelength. Despite our frequent use of the terms "spectra" and "spectroscopy" in connection with this program, it is in fact true photometry. Extinction coefficients in each channel were calculated from frequent standard star observations (usually two or three sets of coefficents per night). Asteroid / standard star ratios were converted to reflectance by calibrating the standard star net to the solar analog star 16 Cygni B. This calibration is completely independent of all previous calibrations using model stellar atmospheres or lunar soil lab spectra, and closely corresponds to that used in the Arizona 8-color asteroid survey (7) so that the IR and photovisual data can be directly compared.

Data products: Out of 36 nights assigned to this program, 28 were acceptably photometric. We obtained about 143 individual full 52-channel spectra of 119 different asteroids. The only taxonomic type which could not be sampled was the rare Q class, since all the suspected members are on Earth-crossing orbits and none made a favorable approach during the survey.

Scientific results: Many interesting discoveries were made in the course of th survey, e. g.: Many asteroid classes including most in the outer belt seem not to be currently delivering any meteorites to the Earth. S-type asteroids are highly variable in olivine/pyroxene ratio, including many objects well outside the chondritic range. The Eos dynamical family is not of conventional S-type material, but may be the source of the CV/CO chondrites (8). At least one Earth-crosser is of basaltic composition (9). The taxonomic types can be grouped into "superclasses" corresponding to the classic igneous, metamorphic and sedimentary rock types. The superclasses are radially arranged in space in such a manner to suggest that the metamorphic heating mechanism declined very rapidly with solar distance (10).

The Big Picture: The following table summarizes the compositional interpretations of the taxonomic types which we have derived from our IR spectra, plus mid-IR, radar, and meterorite data:

TABLE 1:
RELATIONSHIP OF ASTEROID AND METEORITE CLASSIFICATION SYSTEMS

Bell Superclass	Tholen Class	Inferred Minerals	Meteorites
PRIMITIVE	D	Clays, Organics	(None)
	P	Clays, Organics	(None)
	C	Clays, C, Organics	CI and CM chondrites
	(Eos)	Ol, Pyx, Carbon	CV and CO chondrites
METAMORPHIC	T	?	?
	B+G+F	Clays, Opaques	Altered C. C.s
	Q	Pyx, Ol, Grey NiFe	H, L, LL Chondrites
IGNEOUS	V	Plag, Pyx, Ol	Basaltic Achondrites
	R	Ol, Pyx	Ol-rich achondrites?
	S	Pyx, Ol, Red NiFe	Pallasites, Lodranites, Irons
	A	Ol	Brachinites
	M	NiFe	Irons
	E	Fe-free Pyx	Aubrites
	(Mars)		(SNC meteorites)
	(Moon)		(Lunar meteorites)

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