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Abstract

Abundant clinopyroxene on the S asteroids and implications for meteorites and asteroid history and the asteroid-meteorite relationship
Abstract
We have obtained spectra for 25 asteroids in the range 0.8 - 2.5 μm using the NASA IRTF, of which eight were S asteroids. Analysis of their spectra using the Modified Gaussian Model of Sunshine and Pieters (1993) suggests that six of the eight contain significant amounts of pyroxene in the clinorhombic form (CPX), as opposed to the more common orthopyroxene, (OPX). Our pyroxene-rich targets were Hebe (%CPX = 50%), Melponeme (63%), Urda (43%), Ganymed (41%), 1999 JV3 (55%), 1999 CU3 (61%). Clinopyroxene is the low temperature form of pyroxene and is an important diagnostic feature of the primitive (least metamorphosed) ordinary chondrites. Clinopyroxene is also the form of pyroxene associated with igneous meteorites and two V asteroids in our database also contain considerable clinopyroxenes 2003 YQ 117 (50%) and 2002 QF15 (55%). Primitive and igneous meteorites are well-known and widely studied, but numerically they are very rare. The presence of this mineral phase on the surfaces of asteroids therefore has major implications for both asteroid history and the asteroid-meteorite connection.
First, the abundance of CPX on the surface of S asteroids implies either that (1) they are covered with unmetamorphosed material, consistent with an onion skin model in which metamorphism is caused by internal heating and the level of metamorphism experienced by the asteroid decreases with increasing distance from the center, or (2) they are covered with igneous material. Second, the abundance of CPX on the surface of S asteroids is consistent with them not being related to ordinary chondrites, most of which are highly metamorphosed and contain only orthopyroxene (OPX). Space weathering is therefore not the reason for the spectral mismatch between S asteroids and ordinary chondrites.