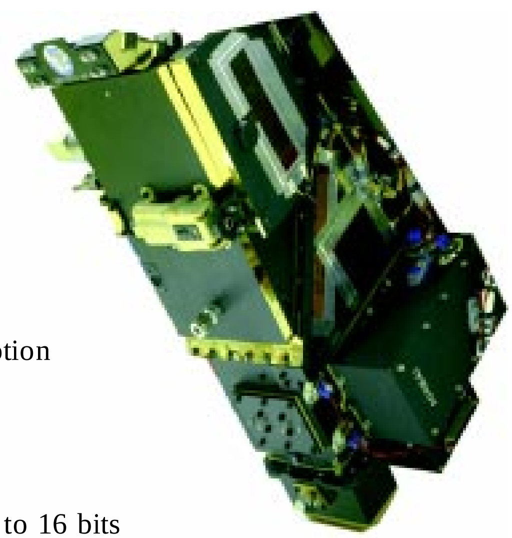
NEAR
Near-Infrared Spectrometer

The Near-Infrared Spectrometer (NIS), one of the five instruments on the NEAR spacecraft, is designed to map the mineralogic composition of the near-Earth asteroid 433 Eros using the spectrum of reflected sunlight. Spectra measured during approach, flyby, and orbit of Eros will cover surface regions as small as 300 meters. Each spectrum has 64 spectral channels covering the near-infrared wavelength region, which allows identification of the key rock-forming minerals exposed on the asteroid surface. Together with measurements of elemental composition from the X-ray/Gamma-ray Spectrometer and high resolution and color imagery from the Multispectral Imager, NIS data will provide a link between asteroids and meteorites and clarify the processes by which asteroids formed and evolved.

Specifications

Mass:	Spectrometer, 10.15 kg Electronics, 5.0 kg
Power:	Spectrometer, 4.3 W Electronics, 10.8 W
Instantaneous field of view:	adjustable to 0.37° × 0.74° or 0.74° × 0.74°; 0.65 × 1.3 km or 1.3 × 1.3 km from a 100-km distance
Total field of view:	scannable over 140° in one axis; second dimension obtained by spacecraft motion
Integration time:	1 s; onboard summation of up to 63 spectra
Detectors and wavelength range:	32-element Ge array: 804–1506 nm in 21.6-nm increments; 32-element InGaAs array: 1348–2732 nm in 43.1-nm increments
Data Character:	64 channels, 12 bits per channel, summable to 16 bits



NIS Description

NIS is a scanning spectrometer that measures near-infrared light in the wavelength range 800–2700 nm. A gold scan mirror that rotates over an angle of 140° controls the direction of viewing. Light reflected from the scan mirror enters through either of two slits that provide a 0.37° × 0.74° or a 0.74° × 0.74° field of view, to accommodate different observation conditions. These provide spot sizes of 0.65 × 1.3 km or 1.3 × 1.3 km from a 100-km distance. The light is dispersed off a diffraction grating onto two detectors. A 32-element germanium (Ge) detector measures the wavelengths 804–1506 nm in 21.6-nm increments; a 32-element indium-gallium arsenide (InGaAs) detector measures the wavelengths 1348–2732 nm in 43.1-nm increments. The gain of the Ge detector can be set at 1× or 10×, to accommodate various illumination conditions. A movable shutter can block the aperture to provide calibration measurements of the background dark level. A solar-illuminated gold calibration target is viewable for radiometric calibration. Individual spectra consist of 12-bit measurements, and up to 63 individual spectra for one spot can be summed onboard. Mirror scanning combined with spacecraft motion will be used to build up spectral images. The computer (digital processing unit, or DPU) is shared with the NEAR magnetometer, and provides the software to control instrument function.

NIS in Flight

The NIS cover was opened in flight in September, 1997. The initial instrument checkout, which included observations of the calibration target, instrument noise level, and empty space, indicated nominal instrument function. The first science data returned by NIS were calibration observations gathered during NEAR's Earth swingby maneuver on January 23, 1998. NIS observed swaths across Asia, Africa, and Antarctica during the swingby and scanned across the Moon three days later. The first NIS spectra released for a geologic target were the observations of Antarctica, where water, water–ice, and atmospheric absorptions were easily resolved by the instrument.

NIS at Eros

Asteroid composition is measured using the spectrum of reflected sunlight. Different materials have characteristic reflectance spectra that serve as identifying "fingerprints." S-type asteroids, like 433 Eros, are composed mostly of iron-bearing silicates (the minerals olivine and pyroxene) and iron–nickel metal alloys. However, the mineralogies of different S-asteroids span a wide range. Meteorite types having these mineralogies have divergent histories: some are pristine, unchanged since the beginning of the solar system; others consist of ancient volcanic rocks; and still others were melted and cooled inside large parent bodies. The correspondence between meteorite and asteroid types remains unknown. Resolving this issue will provide an understanding of early solar system processes that led to the formation of asteroids and meteorites.

433 Eros is in the middle of the S-asteroid mineralogic range. Earth-based spectroscopic studies show that different parts of Eros have different abundances of minerals (one side is more olivine-rich and the other is more pyroxene-rich). The composition and especially the nature of the boundaries between different rock types are key pieces of evidence about how asteroids formed and how they may relate to meteorite origins.

NEAR's battery of instruments is designed to measure the composition and variations of Eros's surface materials using an integrated strategy. NIS is the key to this approach. NIS data will be used to map the distribution and abundance of minerals at scales as small as 300 meters. The Multispectral Imager, with its limited spectroscopic capabilities and 70 times the spatial resolution of NIS, will allow compositional measurements from NIS to be extrapolated down to the scale of meters, revealing details of the physical relationship of discrete materials. The X-ray/Gamma-ray Spectrometer measures elemental distribution and abundance, which, when combined with mineral identification from NIS, will allow definitive identification of the Eros surface rock types. The combined information will be used to synthesize the history of the geologic processes that formed Eros and to clarify the relationship between Eros and meteorites.

Experiment Profile

The NEAR spacecraft has followed a 2-year ΔVEGA trajectory begun with a launch in February 1996. The spacecraft will be inserted into high orbit of Eros in January 1999. Orbit will be progressively lowered over the course of the mission, culminating in a 35-km low orbit. NIS will return spectroscopic measurements during approach and orbit at progressively higher spatial resolutions, including two low-phase angle flybys at the most favorable viewing geometries possible. This first, high-resolution mineralogic mapping investigation of an asteroid will finally clarify the composition and geologic variety of an asteroid and shed light on what processes have produced the asteroids and meteorites.

NIS Team

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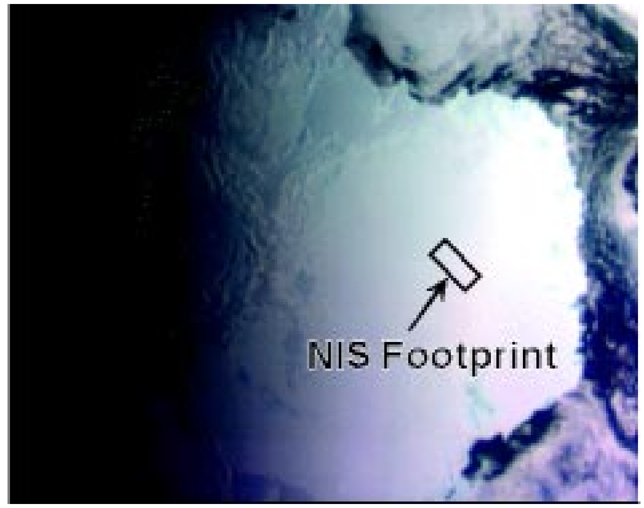

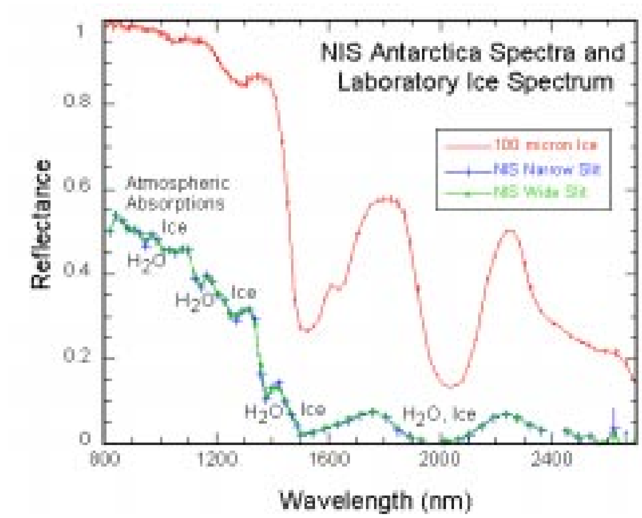

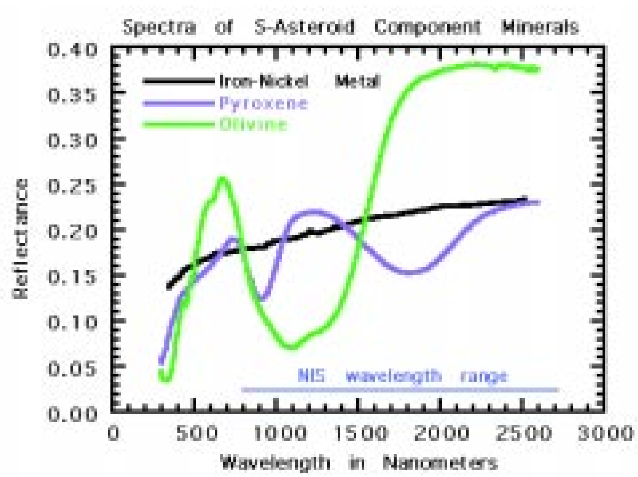

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