the clay formation in Nakhla or Lafayette, which occurred at <180°C [1,2]. Similarly, studies of Lafayette and Nakhla here and elsewhere [7] have not revealed any obvious alteration features associated with this phase. It is believed therefore that the O isotopic composition of the feldspar reflects equilibration at high temperatures, rather than pervasive lower temperature exchange with water of either heavy or light O isotopic composition [3]. In contrast, $\delta^{18}O$ values of olivine and pyroxene do not provide realistic temperatures consistent with equilibration [4]. This is probably due to iddingsite within the olivine, the effect of which is to increase the $\delta^{18}O$ value [3].

Further mineralogical and isotopic data on mineral separates including illite/nontronite are being gathered in order to help characterize the effects and nature of the alteration fluids. It is also hoped to provide in-formation about the $\delta^{17}O$ value of the clay.

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THE STARDUST MISSION: RETURNING COMET SAMPLES TO EARTH.

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Stardust is an approved NASA mission that will collect large numbers of cometary particles and return them to Earth for laboratory analysis. The collected samples will be processed at the Curatorial Facility at the NASA Johnson Space Center in Houston, Texas, where they will be allocated to investigators in a manner similar to the existing lunar sample, cosmic dust, and Antarctic meteorite programs. We urge all investigators interested in primitive materials to begin seriously considering what they would like to do with the samples when they are returned to Earth.

Stardust is the fourth mission in the new NASA Discovery program. It is highly focused on sample return and, following Discovery guidelines, is a low-cost, rapid-development project. The mission will launch in February 1999, fly past Comet Wild 2 on January 1, 2004, and return samples to Earth on January 13, 2006. The spacecraft will collect particles by direct impact into low-density silica aerogel during a 6.1-km/s flyby approaching within 150 km of the nucleus. The particles, ranging in size up to >200 µm, will penetrate several hundred particle diameters into the aerogel, where they will remain until they are extracted in the curatorial facility. The best model of the comet dust production indicates that Stardust will collect more than 20,000 particles >15 µm in diameter in its 1000 cm^2 area of collection surface.

The particles are captured in 2 × 4-cm aerogel tiles. Based on hypervelocity tests, it expected that the particles will partially fragment, but that they will otherwise be well preserved. Laboratory tests at 6 km/s impact speed have shown that solar flare tracks and hydrated silicate basal spacings are preserved during capture. The samples may be heated to several hundreds of degrees centigrade during capture but the heating timescale is only a microsecond. After exposure the samples are retracted into a small atmospheric entry capsule that will directly descend into the atmosphere and land at the Utah Test and Training Range in the Great Salt Lake Desert.

In addition to collection of comet particles the mission will also collect contemporary interstellar dust particles currently entering the solar system, as recently discovered by the Ulysses and Galileo missions. The interstellar particles are collected on the rear side of the collection cells during parts of the spacecraft trajectory that minimize the relative impact velocity. The mission will also carry a dust flux monitor, an imaging camera that will provide 10-m resolution on the nucleus, and a time-of-flight mass spectrometer for *in situ* measurement of cometary, interplanetary, and contemporary interstellar particles.

PETROGENETIC HISTORY OF THE PIPLIA KALAN EUCRITE.

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Piplia Kalan is an equilibrated eucrite that was previously described by Vaya et al. [1] and Buchanan et al. [2]. Mineral chemistry is similar to those of the main group eucrites Juvinas and Sioux County [3]. Ophitic/subophitic eucrite clasts display finer- and coarser-grained textures (lithologies A and B, respectively) [1]. Also included among lithic clasts in this meteorite are porphyritic materials with fine-grained, equigranular mesostasis; we interpret these materials as metamorphosed vitrophyres. Despite textural variations, compositions of individual lithic clasts and brecciated matrix are similar in major-and trace-element abundances and are similar to the composition of Juvinas (Table 1). The small compositional differences among the clast and matrix samples are plausibly due solely to sampling effects (heterogeneities). Hence, the meteorite is a monomict breccia that is plausibly composed of fragments of a single lava flow, including fine-grained crust and a more slowly cooled, coarser-grained interior. The presence in Piplia Kalan of a large proportion of lithic clasts (~60–80 vol%) compared to the proportion of matrix (~20–40 vol%) suggests that the original brecciation event was caused by a low-energy impact that limited brecciation effects, and is consistent with the meteorite representing a single lava flow.

Both feldspars and pyroxenes within ophitic/subophitic clasts in Piplia Kalan contain abundant inclusions. These inclusions and the granular texture of the mesostasis of the porphyritic clasts suggest an episode of post-crystallization thermal metamorphism. The brecciated matrix of the meteorite has nonporous texture similar to that of the polymict eucrite Petersburg, which experienced postbrecciation thermal metamorphism [4,5]. Piplia Kalan

TABLE 1. Compositions determined by INAA of lithologies A and B and matrix of Piplia Kalan compared with mean of literature data for Juvinas.

	Lithology A Finer-grained	Lithology B Coarser-grained	Matrix	Juvinas Literature Mean
Mass (mg)	88.61	84.41	65.35	
Na_2O (wt%)	0.477	0.497	0.462	0.431
K (ppm)	320	260	320	340
CaO (wt%)	10.1	9.9	9.9	10.7
Sc (ppm)	32.0	28.6	32.3	28.9
Cr_2O_3 (wt%)	0.343	0.379	0.303	0.286
FeO (wt%)	19.2	18.9	19.2	18.0
Co (ppm)	5.25	4.03	4.65	4.61
La (ppm)	2.73	2.60	3.11	2.59
Ce (ppm)	7.8	7.0	8.0	6.8
Sm (ppm)	1.78	1.60	1.94	1.62
Eu (ppm)	0.62	0.64	0.62	0.62
Tb (ppm)	0.44	0.42	0.48	0.42
Yb (ppm)	1.84	1.68	1.92	1.68
Lu (ppm)	0.265	0.248	0.281	0.248
Hf (ppm)	1.41	1.27	1.52	1.19
Ta (ppb)	200	140	180	160
Th (ppb)	290	270	320	290