73275

Micropoikilitic Impact Melt Breccia
St. 3, 429.6 g

INTRODUCTION

73275 is a clast-bearing micropoikilitic impact melt breccia that has a chemical composition similar to the low-K Fra Mauro melts common at the site and generally presumed to represent the Serenitatis impact melt. An Ar-Ar age of about 3.90 Ga has been determined and it had a multi-stage exposure history. 73275 was collected from the surface on the rim of the 10-m crater at Station 3. The sample is light gray, tough with no penetrative fractures, and is homogeneous. Matrix material smaller than about 100 microns constitutes about 95% of the rock. It is 10 x 7 x 7 cm and blocky or subangular. Its surface is uneven, with many zap pits on most sides, but one area has a fresh fracture surface (Fig. 1). It has 2-3% vugs up to 6 mm in dimension, ranging in shape from near-hemispherical to slit-like; some have drusy linings. A slab was sawn through the rock (Fig. 2) and provided most but not all of the allocated subsamples.

PETROGRAPHY

No detailed description of 73275 has been published. It is a clast-bearing impact melt with a micropoikilitic texture (Fig. 3a,b,c). It is a homogeneous melt with an appearance very much like that of finer-grained "Serenitatis" melts. Large clasts are uncommon in the thin sections; those lithic clasts present are dominantly granoblastic impactites and coarse-grained feldspar-rich samples with plutonic igneous textures. Mineral

Figure 1: Pre-processing photograph of 73275, showing common eroded surface with patina and zap pits (left) and fresh broken surface (right). Scale divisions 1 cm S-73-16929

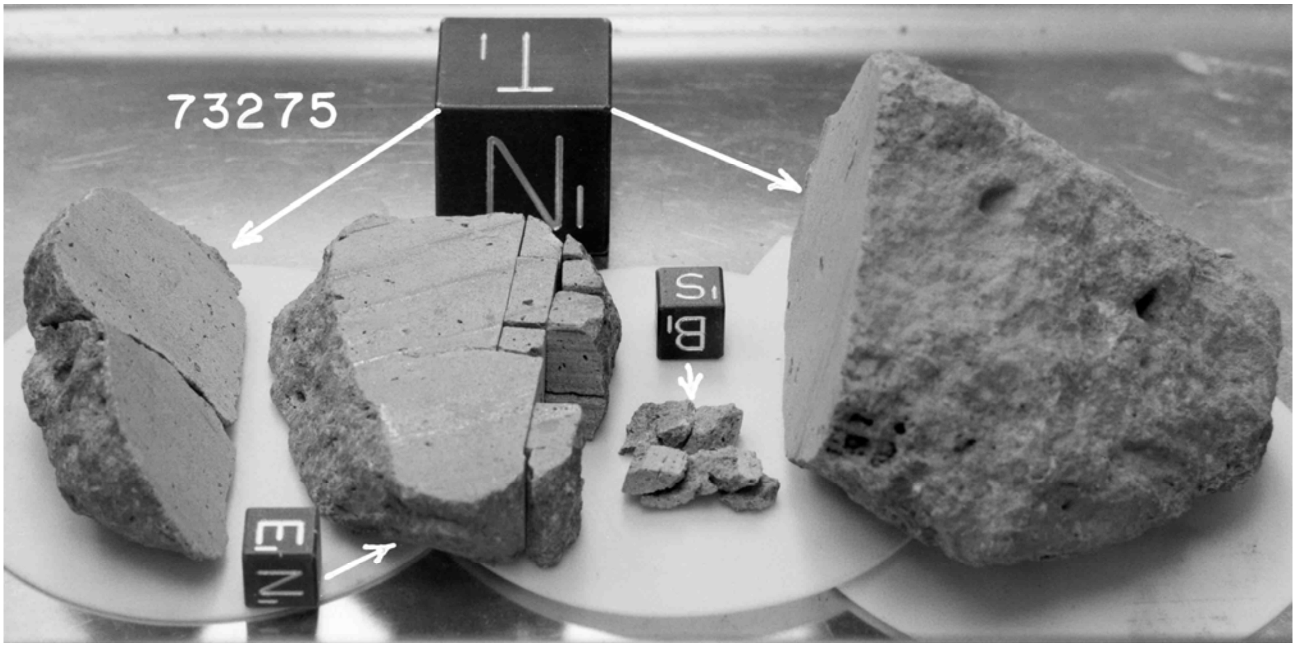


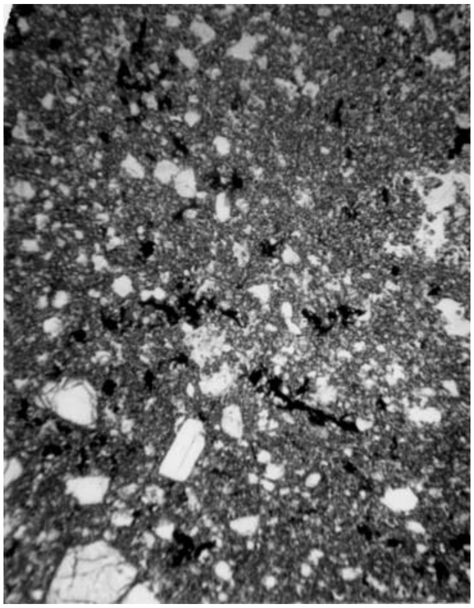
Figure 2: Slab cut of 73275. Small butt end, 2 (left) was partly broken. Large butt end,1 (right, 274 g)) was retained intact The slab piece (center) is,3. Further subsample numbers not shown. Small cubes are 1 cm. S-73-34459.

clasts are dominantly plagioclase, with nonetheless conspicuous olivine and some pyroxene. The groundmass consists of tiny equant plagioclases and larger but still small (less than 150 micron, generally) oikocrysts of pyroxene; ilmenite is prominent as lathy to equant grains (Fig. 3a, b). In a few areas, tiny clasts are less abundant and the groundmass consists of elongated plagioclases ophitically enclosed in more clearly visible pyroxenes (Fig. 3c).

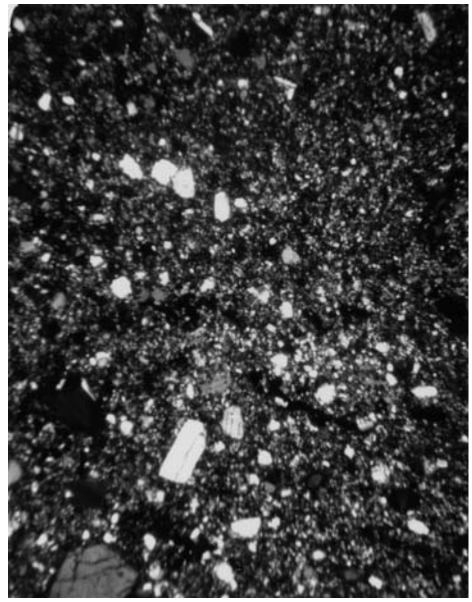
Simonds et al. (1974) listed 73275 as a rock with 50-60% feldspar and a subophitic-micropoikilitic texture. The tabulated matrix feldspar as 10-50 microns and matrix mafic grains as 10-100 microns in dimension. Their pyroxene and olivine analyses (Fig, 4) are similar to those of the other common melt rocks at Apollo 17, although some of the groundmass pyroxenes are of more magnesian composition (as much as Mg 86). Engelhardt (1979) tabulated the paragenesis as one having ilmenite crystallization entirely post-date that of pyroxene. Heuer et al. (1974) and Radcliffe et al. (1974) described 73275 as a recrystallized breccia with low porosity. They found that the rock consisted of large clasts of plagioclase (0.3-1.00 mm), with smaller olivines (0.05-0.2 mm) and orthopyroxenes (0.1-0.2 mm) in a fine-grained recrystallized groundmass of the same phases. Many of the plagioclases have rims separated from the clasts by a ring of dark inclusions; the clasts are more calcic (An_{90-97}) than the presumed overgrowth rims (An_{85-90}). Electron transmission studies showed that their were dislocation substructures in plagioclases and are associated with pores; there is some evidence of recovery. These authors provide electron transmission photographs. There are well-developed type (b) antiphase domains in plagioclase, and features due to movement of disassociated dislocations. In clinopyroxenes there are thin widely-spaced exsolution lamellae suggestive of prolonged annealing. Goldstein et al. (1976a, b) described the rock as having a fine-grained groundmass with plagioclase laths enclosed by poikilitic pyroxenes 0.1-0.5 mm across. Most of the clast are single crystal, but there are also coarse-grained granulites and devitrified plagioclase glasses. The focus of the study by Goldstein et al. (1976a, b), however, was the presence of the carbide phase cohenite ((Fe, Ni) 3C) which occurs with kamacite interstitial to silicates. They depicted an example and made microprobe analyses across grains (Fig. 5).

CHEMISTRY

Chemical analyses are given in Table 1. Most of these were originally published with little specific comment, other than the general similarity with typical "Serenitatis" melt rocks. The little available rare earth element data are consistent with that similarity. The analyses demonstrate the similarity with common meteorite-contaminated melt rocks such as the Station 6 boulder and not with the aphanitic melt rocks, which have higher alumina and lower titania. Morgan et al. (1976) assign the sample to their Group 2, the "Serenitatis" group, on the basis of meteoritic siderophile ratios.

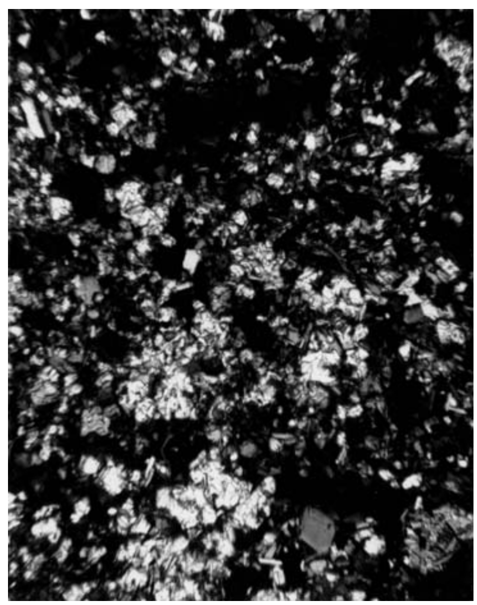


a



b

Figure 3: Photomicrographs of 73275, 62. a,b) Same view with plane transmitted light (a) and crossed polarizers (b) of general clast-bearing micropoikilitic groundmass. Small clasts are obvious. Field of view about 2 mm wide. c) detail of ophitic, class poor area with lathy plagioclases. Crossed polarizers; field of view about 500 microns wide.



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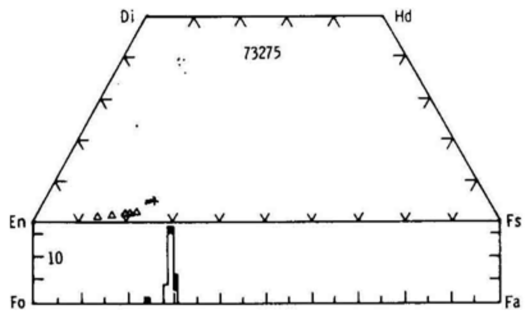

Figure 4: Microprobe analyses of pyroxenes and olivines in 73275,60. Open symbols and dots are groundmass phases, closed symbols are clasts. Simonds et al. (1974).

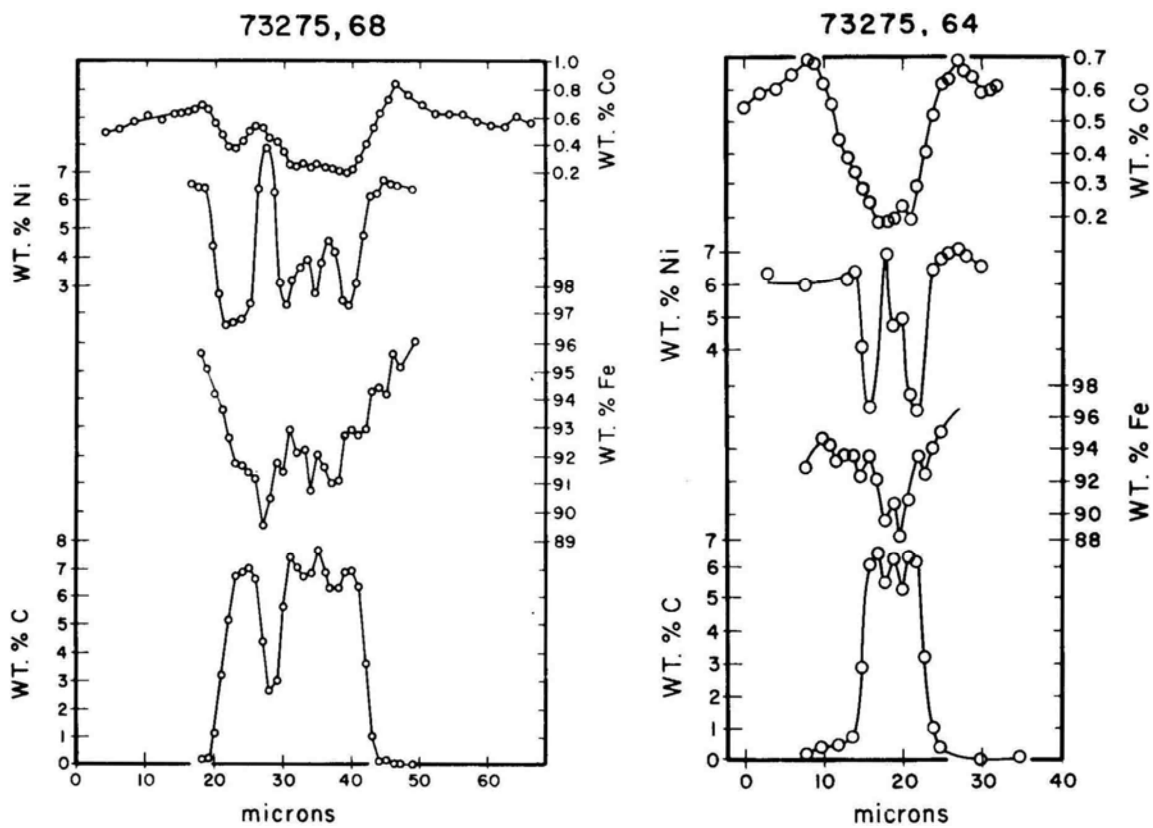

Figure 5: Profiles across Fe-meta/cohenite grains in thin sections of 73275. Goldstein et al. (1976x).

Table 1: Chemical analyses of bulk samples of 73275.

Split	,30	,0	,23	,24	,27	,28	,22
wt %							
SiO_2	46.16						
TiO_2	1.43						
Al_2O_3	18.49						
Cr_2O_3							
FeO	9.05						
MnO	0.13						
MgO	11.54						
CaO	11.30						10.5
Na_2O	0.67						
K_2O	0.27	0.269					0.28
P_2O_5	0.26						
ppm							
Sc							
V							
Co							
Ni			182				
Rb	6.62		6.9			9.11	
Sr	171.8					185.5	
Y							
Zr							
Nb							
Hf							
Ba							
Th		4.53				4.97	
U		1.20	0.136		1.1	1.31	
Cs			0.270				
Ta							
Pb						2.8	
La							
Ce							
Pr							
Nd						50.67	
Sm						14.30	
Eu							
Gd							
Tb							
Dy							
Ho							
Er							
Tm							
Yb							
Lu							
Li					9.4		
Be							
B							
C							
N							
S	800			927			
F					30		
Cl					(a)11.89		
Br			0.073		(a)0.115		
Cu							
Zn			2.5				
ppb							
Au			3.34				
Ir			5.71				
I					0.9		
At							
Ga							
Ge			265				
As							
Se			92				
Mo							
Tc							
Ru							
Rh							
Pd							
Ag			0.74				
Cd			4.1				
In							
Sn							
Sb			1.19				
Te			5.5				
W							
Re			0.494				
Os							
Pt							
Hg							
Tl			1.60				
Bi			0.16				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

References and methods:
(1) Rhodes et al. (1974a,b), Nyquist et al. (1974a);XRF, AA, IS/MS
(2) Eldridge et al. (1974a,b); Gamma-ray spectroscopy
(3) Morgan et al. (1974a,b, 1976); RNAA
(4) Gibson and Moore (1974a,b)
(5) Jovanovic and Reed (1974a,b,c, 1980a); RNAA
(6) Oberli et al. (1978; ID/MS
(7) Turner and Cadogan (1974a); from Ar-Ar irradiation

Notes:
(a) Combined leach and residue.

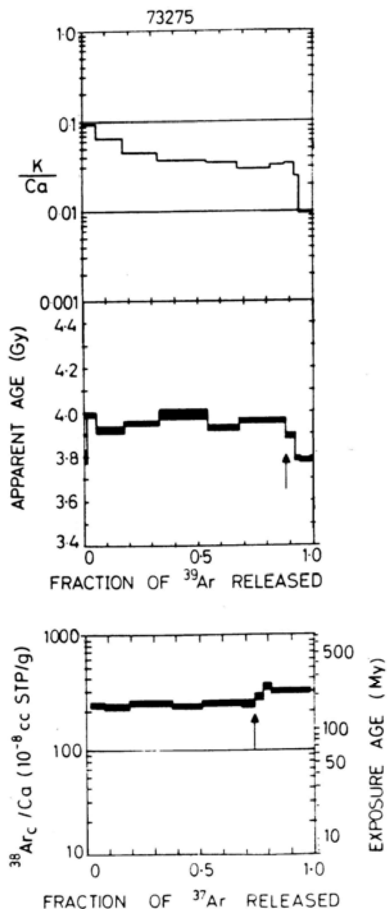

Figure 6: Ar release and apparent age with K. Ca, and Ar exposure age of 73275,22. (Turner and Cadogan (1975a).

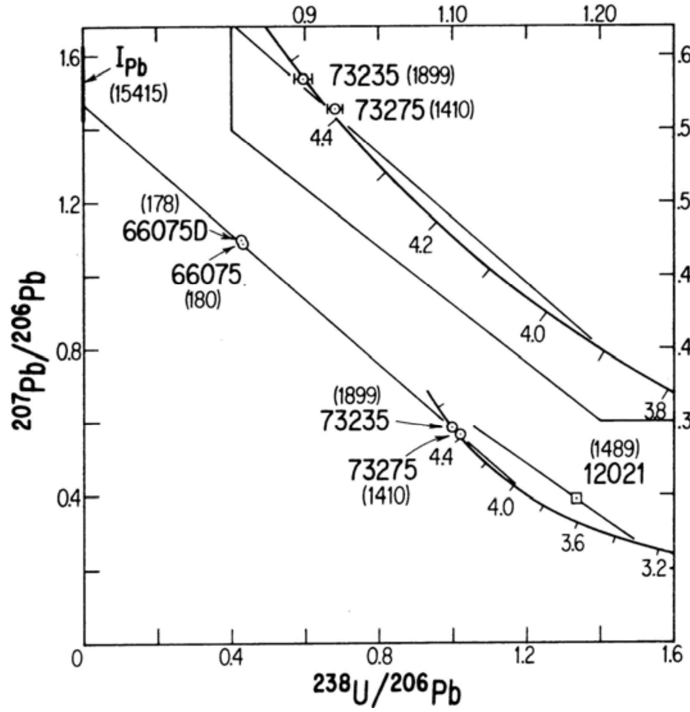

Figure 7: U-Pb evolution diagram for 73275,28 and other samples. The u values are given in parentheses. A reference line is drawn through points corresponding with 4.42 and 3.9 Ga. Oberli et al. (1978).

GEOCHRONOLOGY AND RADIOGENIC ISOTOPES

Turner and Cadogan (1974a, b) reported Ar-Ar release data. The data provide an extended plateau (Fig. 6) with a small high-temperature release. However, their is a fine structure in the plateau which is real and outside of experimental error. The apparent age is 3.90 +/-0.05 Ga (new decay constants; old decay constants 3.96 Ga), and the total Ar age is identical.

Nyquist et al. (1974x) provided Rb and Sr isotopic data that is similar to the other "noritic breccias" that they analyzed, falling on the same 3.96 Ga (new decay constants) line of unclear significance. The $^{87}Rb/^{86}Sr$ = 0.1112 +/-10 and the $^{87}Sr/^{86}Sr$ x.70619 +/-5. These data provide T_{Babi} of 4.39 +/-0.07 Ga (new decay constants) and T_{Luni} of 4.42 +/- 0.07 Ga. Oberli et al. (1978) provided corresponding isotopic ratios of 0.1598 and 0.70870 +/-5, and T_{Babi} of 4.18 +/-0.03 Ga (new decay constants). As for sample 73235, the young Rb-Sr model ages imply that either crust formation occurred at these late model ages or that remelting of materials relatively rich in Rb/Sr took place then.

Oberli et al (1978) also provided Sm-Nd and U-Th-Pb isotopic data. The $^{147}Sm/^{144}Nd$ of 0.1708+/-1 and the $^{143}Nd/^{144}Nd$ of 0.511092+/-19 give T_{Juv} of 4.51 +/-0.02 Ga and T_{Chur} of 4.91 +1-0.15 Ga. As for sample 73235, these model ages are older than the Rb-Sr model ages, implying that the events that lead to Rb/Sr increases in the history of these samples were not accompanied by changes in the Sm/Nd ratio The U-Th-Pb isotopic data are marginally concordant at 4.42 Ga. (Figure 7). However, the tangential relationship (again, like 73255) is poorly suited to discriminating a disconcordant array. The $^{207}Pb/^{206}Pb$ age is 4.418 +l-2 Ga, the $^{206}Pb/^{238}U$ age is 4.404 +16/-17 Ga, and the $^{208}Pb/^{232}U$ age is 4.379 +/41 Ga.

RARE GASES AND EXPOSURE

It is apparent that 73275 had a multi-stage exposure history. Turner and Cadogan (1974a) derived a nominal exposure age of 160 Ma from $^{38}Ar_c/Ca$ data (Figure 5). Crozaz et al. (1974a, b) repotted Kr isotopic data and spallation spectra They derived an exposure age of 139 +1-5 Ma. This Kr data and also xenon isotopic data was also discussed by Arvidson et al. (1976). The relatively high $(^{131}Xe/^{126}Xe)$, of 5.7 and the fact that the $(^{80}Kr/^{83}Kr)c$ and $(^{82}Kr/^{83}Kr)_c$ are the highest among the samples they analyzed indicates substantial shielding and is inconsistent with a simple surface history. They suggest that the Kr age of 139 Ma overestimates the true surface residence time.

Crozaz et al. (1974a, b) also reported nuclear track data for 73275, giving 4.7 +/-1 Ma for a single point determination at 2.9 +/- 0.4 cm depth, which provides a maximum surface exposure. They suggest (using soil radiation data also) that the age of Ballet Crater is 5 to 20 Ma. Goswami and Lal (1974) also studied track densities, giving a "sun tan" age of 1.2 Ma and a subdecimeter age of about 8 Ma. The "sun tan" age suggests frequent chipping of the rock. The flattening of the track profiles at depths greater than 1 cm clearly show a multiple exposure history. No pre-irradiated components were found among feldspar clasts.

Yokoyama et al. (1974) found the sample to be saturated in ^{22}Na and ^{26}Al the latter requiring exposure of at least 2 or 3 Ma.

PHYSICAL PROPERTIES

Huffman et al. (1974a) and Huffman and Dunphyre (1975) used Mossbauer and magnetic methods to understand the state of iron in various phases of 73275. 96.1 % of the total Fe is in silicates (66.3% in pyroxenes, 29,.8% 9 in olivines), 3.2% in ilmenite, 0.7% in FeS, and 0.735% as Fe^O. The total Fe^{2+} is 8.5%. They were conducting low-temperature Mossbauer studies of superparamagnetic clustering of Fe^{2+} spin in lunar olivines.

Nagata et al. (1974a, b, 1975a) tabulated some magnetic data for 73275,15 (Table 2) in a study that was partly meant to elucidate the origin of lunar iron. Housley et al. (1976) found no FMR intensity (unlike soils) in their magnetic study of 73275,25.

PROCESSING

A sawn slab (,3) was produced in 1973, with exterior and interior pieces. Several chips were taken from exterior areas for exposure and other studies (Fig. 2). Two of these (,4, and, 6) were made into potted butts for thin sections. Some subdivisions and allocations were made from end piece ,2, which is now 26 g. Further chipping from the subsamples was conducted in 1975. The large end piece ,1 is now 274 g, and the largest remaining slab piece (,3) is 69 g. The three large pieces account for all but about 60 g of the original sample.

Table 2: Magnetic data for 73275,25. Nagata et al. (1974a).

Parameter	(Br)	Unit
I_n	13.4	$\times 10^{-4}$ emu/g
I_0	1.1	$\times 10^{-6}$ emu/g
$\tilde{H}_0$	105	Oe · rms
h	13	Oersteds
$\tilde{H}'_0$	3	Oe · rms
$\Delta I_v / I$	0.08	
Stability of NRM	(3)	