THE TAMBAKWATU CHONDRITE

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According to its petrography, uniform olivine, $Fa_{23.8}$, and pyroxene, $Fs_{20.4}$, a total iron content of 22.9 wt % Fe, 16.4 wt % FeO and an FeO/FeO + MgO ratio of 24.7 mol %, the Tambakwatu is a veined, intermediate hypersthene (Cia) or L6 chondrite.

INTRODUCTION

Before midnight on February 14, 1975 this meteorite was seen to fall in the countryside of the Purwosari district in East Java, near the village of Tambakwatu geographically located at 7°45′S., 112°46′E. One stone weighing 10.5 kg was recovered by the Jakarta Planetarium, which still has the main mass. The volume was determined by immersing the stone in water; the density then was estimated to 3.49. A sample weighing nearly 700 grams (Fig. 1) was broken off the main mass and transferred to the Smithsonian Institution. Approximately 10 grams of this specimen was used in our study; the remainder (USNM #6026) is in the collection.

TEXTURE AND MINERALOGY

As shown in Figure 1, a freshly broken surface in a hand specimen of the meteorite appears light grey with extensive veining and iron oxide stains throughout. The rather poorly defined chondrules break with the groundmass. Under the normal part of the dull, black fusion crust which is a network of iron oxides and cryptocrystalline material surrounding mineral grains, vugs, and glass, an additional thin, semi-opaque layer impregnated with sulfides and oxides was observed (Fig. 2). Apparently melt crust accumulated preferentially on this side of the stone.

Modal analysis by point counting one thin section, a total of $\sim$ 1 cm^2, reveals that Tambakwatu is about 87 wt % silicates, 8 wt % metal, 4.5 wt % troilite and 0.5 wt % chromite. Chondrules, most of which are barred or porphyritic, generally are fragmented with barely distinguishable boundaries.

Olivine, the dominant phase, and orthopyroxene grains are highly fractured and show undulatory extinction (Fig. 3). Electron probe analyses of 65 olivine grains vary by only 1.3 percent mean deviation (PMD(from $Fa_{23.8}$ (Fig. 4). The average composition of 30 orthopyroxenes is $Fs_{20.4}$ with 1.1(PMD)(Fig. 4). A few high calcium pyroxenes were too small for accurate probe analysis. Plagioclase ($Or_7Ab_{81}An_{12}$) occurs

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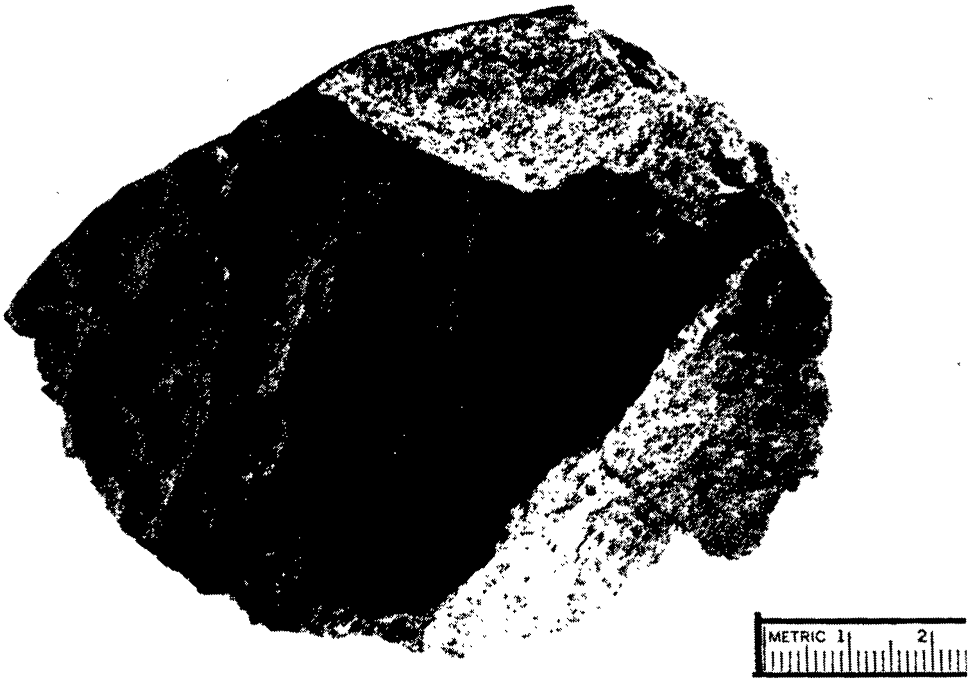

Fig. 1 700 g specimen of Tambakwatu. Note black veins on lower right. Most darker spots on broken faces are rust stains. Scale in centimeters. Photo by V. Krantz, Smithsonian Institution.

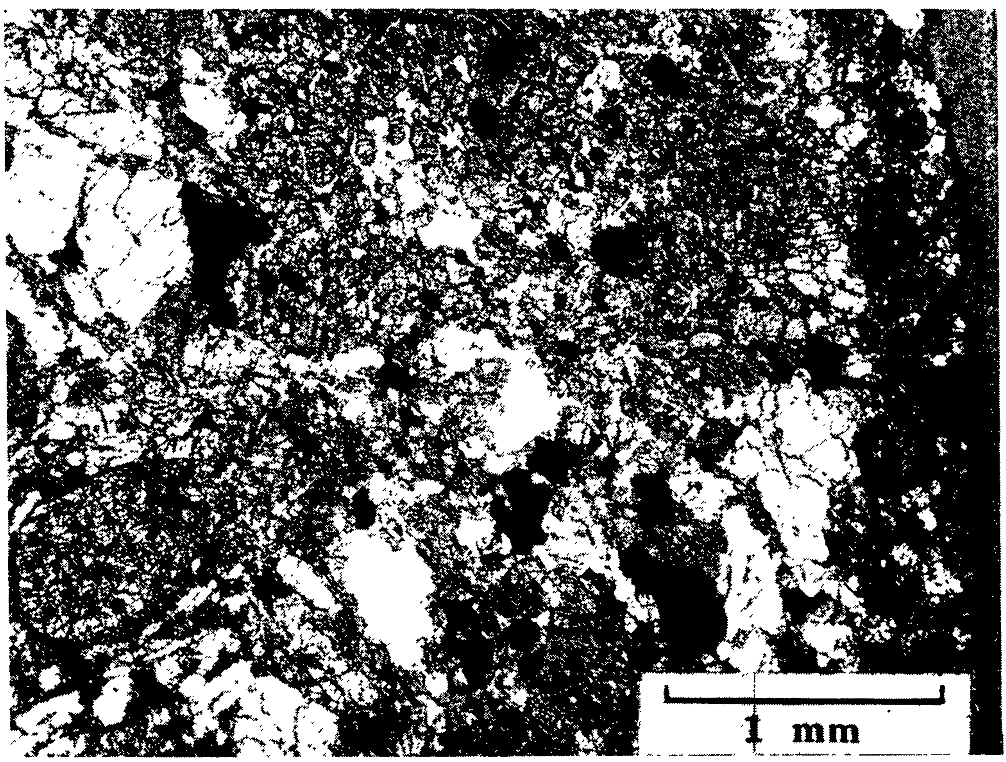

Fig. 2 Thin section of Tambakwatu showing fractured pyroxenes and olivines with undulatory extinction. Two chondrules, left, are well integrated with matrix. Black, partly glassy crust with vugs, right. Semi-polarized light. Scale bar 1 mm.

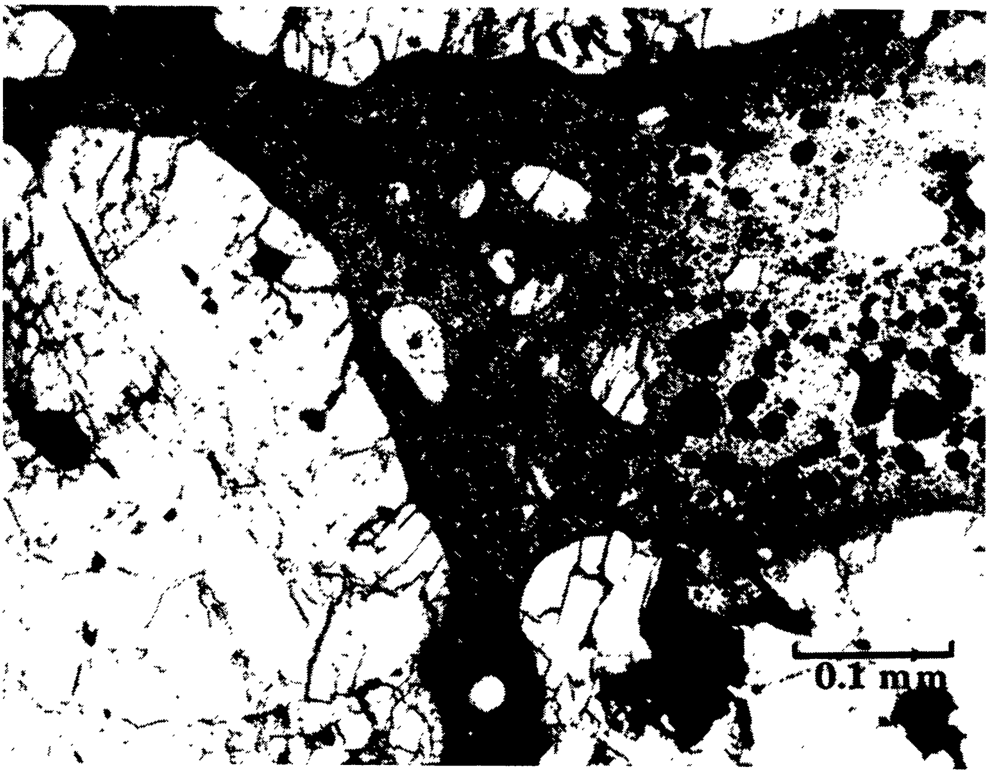

Fig. 3 Partly recrystallized or devitrified, branched, shock vein, dark grey, with eutectic metal-sulfide spherules, black, and a few remaining shocked olivines. Note also the shock induced fracturing and the undulating extinction in adjacent large olivines which is made vividly (true colors anomalous wavy blue) visible between near-parallel polarizers. Scale bar 0.1 mm.

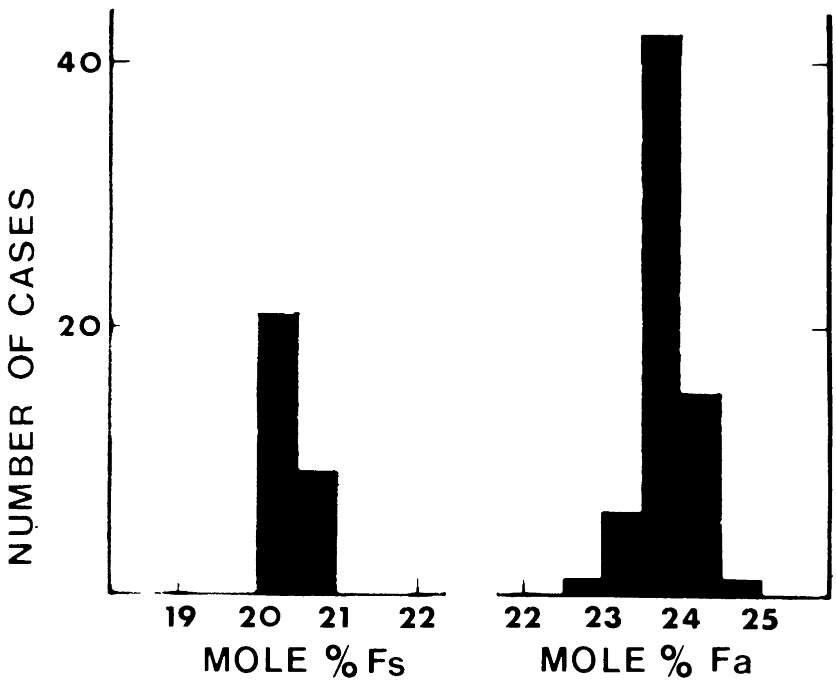

Fig. 4 Olivine and pyroxene composition in Tambakwatu. Average Fa = 23.8 (PMD 1.3) and Fs = 20.4 (PMD 1.1).

Table 1. Composition of the Tambakwatu L-Chondrite.

Composition of Silicate + Sulfide Portion[1]	Wt %	Norm of Silicate + Sulfide Portion[1]	Wt %
SiO_2	44.9		
Al_2O_3	2.03	Olivine	52.0
FeO	16.4	Hypersthene (En_{75})	27.2
MgO	28.1	Diopside	7.8
CaO	2.30	Albite	8.2
Na_2O	0.96	Anorthite	0.9
K_2O	0.13	Orthoclase	0.7
FeS[2]	5.28	Troilite[2]	5.3
Ni_{met}[1]	0.18		
SUM	100.28		
Total Fe[3]	22.9		
FeO/FeO+MgO =	24.7 mol %		

Mode in Wt %	
Silicates	87.0
Metal[3]	8.0
Troilite	4.5
Chromite	0.5

Electron probe analyses
65 olivines and 30 pyroxenes

	$\overline{Fa}$	$\overline{Fs}$	PMD	$\overline{CaO}$ wt %
Olivine	23.8		1.3	
Pyroxene		20.4	1.1	0.84

1) Metal extracted; Ni_{met} indicates small amounts of fine-grained Ni-rich metal remaining.

2) From measured 1.92% S (~4.9% of total; compare 4.5 modal FeS). Equivalent FeO deducted.

3) 6.8% modal Fe metal assuming average L-group Ni content of 1.2%.

as interstitial grains and also as brownish impact glass which was usually observed adjacent to metal and troilite grains. Figure 3 shows part of a typical shock vein with eutectic Ni/Fe and Ni/FeS spherules which, like the undulating extinction in most olivines, indicates shock pressures in the 3-400 kb range or higher.

CHEMISTRY

A bulk electron probe analysis using a defocused beam was performed on pellets of pressed, small (~ 1 g), pulverized samples from which metal had been removed magnetically. For details of the technique see Youngblood *et al.* (1978) and Miller *et al.* (in press). Total iron was calculated from the FeO value obtained by the probe analysis and the modal metal content. The Niggli method discussed by Hutchinson (1974) was used to determine the normative mineralogy. The results are presented in Table 1.

CLASSIFICATION

According to classical nomenclature, Tambakwatu is a veined, intermediate hypersthene chondrite (Cia). Pyroxene and olivine compositions are clearly in agreement with an L-group classification (Keil and Fredriksson, 1964). Bulk chemical data are also consistent with average L chondrite values (Mason, 1968). Following Van Schmus and Wood's (1967) classification scheme, Tambakwatu is an L6 chondrite. Chondrule boundaries are barely defined, orthopyroxene is the predominant metasilicate and some well defined plagioclase grains are present.

ACKNOWLEDGMENT

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NOTE

Point counting on another surface (2 cm^2) gave, in wt %, 83 silicate, 9.9 metal, and 6.5 troilite.

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