Shock-metamorphism in Sixiangkou Chondrite from China

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1. Introduction

The Sixiangkou Meteorite fell in Sixiangkou town, Taizhou city, Jiangsu province of China on June 15th 1989. The microscopic examination shows that it is an olivine-bronzite chondritic meteorite and composed mainly of olivine (40%), bronzite (32%), plagioclase (10%), kamacite (7%), troilite (6%) and a few Ca-rich salite, whitelockite and cristoblite.

The chemical phase analysis of this chondrite as following:

Table 1 Chemical composition of the Sixiangkou chondrite

SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O
38.94	0.10	2.62	0.55	15.84	0.35	24.54	1.88	1.01	0.11
H_2O+	H_2O-	P_2O_5	FeS	Fe^0	total Fe	Ni	Co	Cu	total
0.05	0.06	0.20	6.25	6.02	22.30	1.21	0.05	0.03	99.81

Based on the chemical-petrologic classification for the chondritic meteorites (Schmus 1967), the Sixiangkou Meteorite is of group L (table 2) and type 5. Consequently, the Sixiangkou Meteorite is determined to be L−5 chondrite.

Table 2 Chemical parameters or the Sixiangkou chondrite

Chemical parameters	SiO_2/MgO	$FeO/(FeO+MgO)$	Fe/SiO_2	Fe^0/Fe
Group H	1.55±0.05	18±2	0.77±0.07	0.63±0.07
Group L	1.59±0.05	24±2	0.55±0.05	0.33±0.07
Group LL	1.58±0.05	29±2	0.49±0.03	0.08±0.07
Sixiangkon chondrite	1.59	26?	0.57	0.27

2. Samples and Methods

Thin section and polished section of meteorite samples were prepared to study the mineral composition and microtexeture by microscopy. The chemical composition of the microstructure was determined by EPMA (JXA−8800). The TEM observations were made with a JEM−200CX electron microscope, the accelerated votage was 200kV. The specimans was sprayed a very thin carbon film after being ion-thinned.

3. Shock-metamorphism in Sixiangkou chondrite

3.1 The petrographic and scanning electron microscopic observation: shows that the Sixiangkou Meteorite was shock-metamorphosed intensively. The olivine phenocrystal were crushed and change to fine-grained on its periphery. The olivine grains show undulatory extinction. In addition, there are two sets of glide planes, perpendicular to each other. Pyroxene became round out-

side and had mechanical twins inside. The twin lamellae arrange closely. Feldspar displays shock metamorphism for transformation into maskelynite, however, there remains a few albite twins. Troilite assembled and enlarged.

Shock-metamorphism is the most common phenomenon in the chondritic meteorite. Previous study reported that Group L chondritic meteorite was shocked more strongly than Grop H. Dodd (1979) investigated 52 L4—L6 chondritic meteorites, including 30% shock phase b+c and 40% shock phase e. Sixiangkou Meteorite was shocked with a peak pressure of about 45 GPa, about the same as shock phase e.

3.2 Dislocations in Olivine

EMPA results of olivine composition shows higher Fa, ranging from 25—27. In olivine grains with strongly shock-metamorphism two sets of deforming slide planes exist like pyroxene eleavages, their composition is olivine while Fa rises to 28—30. The edges of phencrysts were obviously granulated.

The bright field images show two main types of dislocation in the olivine. One is relatively straight and parallel to [010]. The other is slightly bended and parallel to [001]. The Buurgers vector for both of them are parallel to [010]. Consequently, the straight one is the screw dislocations and the bended is the edge dislocations. Based on the statistics of 25 photomicrographes, the dislocation density ρ is $4.13\times10^{10}/cm^2$. Sometimes the jogs and small dislocation loops can be found as well. However, the dipole, network and helical dislocation have never been found.

The authors come to the conclusion that the Sixiangkou chondritic meteorite was formed under a rapid condensation and was not thermally metamorphosed strongly. The dislocation of the olivine was formed as a consequence of the shock of high strain rate at the temperature of 800—1000℃.

3.3 TEM study on twins in pyroxene

Crossed polarizer observations show that the diopside in the meteorite contains obvious twin lamellae. TEM studies also show two electron diffraction patterns with different strength and certain relationship. One lattice with smaller spots and closed arranging is parallel to boundrary, both sides of which are the same composition detected by X—ray EDS, showing twin relationship.

3.4 The maskelynite in Sixiangkou chondrite has been studied with SEM、TEM and EPMA. It has been found that there are two occurences of the maskelynite. One is the interstitial grains between olivine, diopsite, bronzite, kamacite and troilite. They are amorphous. The other occurs within the barred olivine and bunched bronzite chondrules. They remain partially as crystalline phase. Based on the maskelynite features and the barred structure of olivine it is proposed that the shock pressure experienced by the Sixiangkou chondrite was in the range 35~50 GPa and is corresponding to the strongly shocked stage in the Stoffler's classification or the e-shock phase in the Dodd's classification.

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