

**Tissint (shower)**  
**12+ kilograms (total found)**  
Depleted Olivine-phyric Shergottite

*DRAFT*



*Figure 1: Photo of 1.3 kg. piece of Tissint (unknown-possibly BMNH).*

**Introduction**

The Tissint meteorite was seen to fall as a shower over Morocco on July 18, 2011 (Chennaoui Aoudjehane 2012; Irving 2012). Several large pieces (over 1 kg.) and many smaller fragments were found, starting in October 2011 (a total of over 12 kg.). All had nice black fusion crust, and appeared to be very fresh and unaltered (figure 1). The area is being continually searched; so carefully, that other meteorites should be found as well (Ibhi 2012).

Tissint is a picritic basalt from Mars that is about 600 m.y. old and took about 1.1 m.y. to get here (based on cosmic ray exposure). There is so much of it, and it is so fresh, that every possible experiment will probably be performed on it, although it appears to be a rather typical Martian basalt. Stay tuned -



**Figure 2:** This piece of Tissint is being studied in Paris (photo by Stefan Radew). Note the apparent melt inclusions.

### **Petrography**

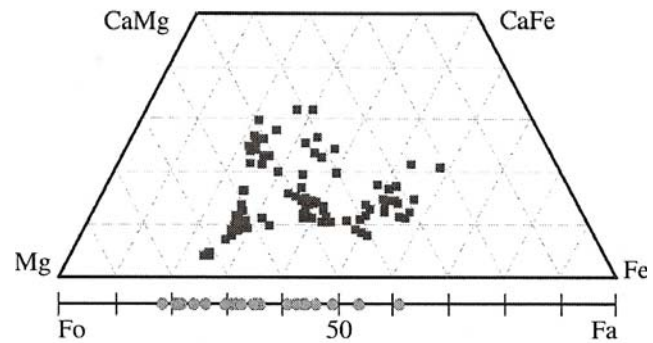
Tissint is an olivine rich basalt with two generations of olivine (figure 2). Large, rounded olivine megacrysts appear to be more mafic than the rock. Olivine phenocrysts are also present in the matrix, but have less Mg and more iron. Olivine has both melt inclusions and small euhedral chromite grains. Figure 3 shows the over all texture.

Tissint is highly shocked, as is evidenced by maskelynite (figure 5). Reports on other, high-pressure shock phases are soon to follow -

Tissint has obvious “pods” or pockets of impact-produced glass – see figure 2. These need to be examined to see if they have similarity to the “pods” in EETA79001, or if they contain evidence of the composition of the Martian atmosphere.

### **Mineralogical Mode for Tissint**

	Hsu et al. 2012
Olivine	12 % + 17 %
Pyroxene	53 %
Plagioclase	12 %
Phosphate	minor
Oxides	



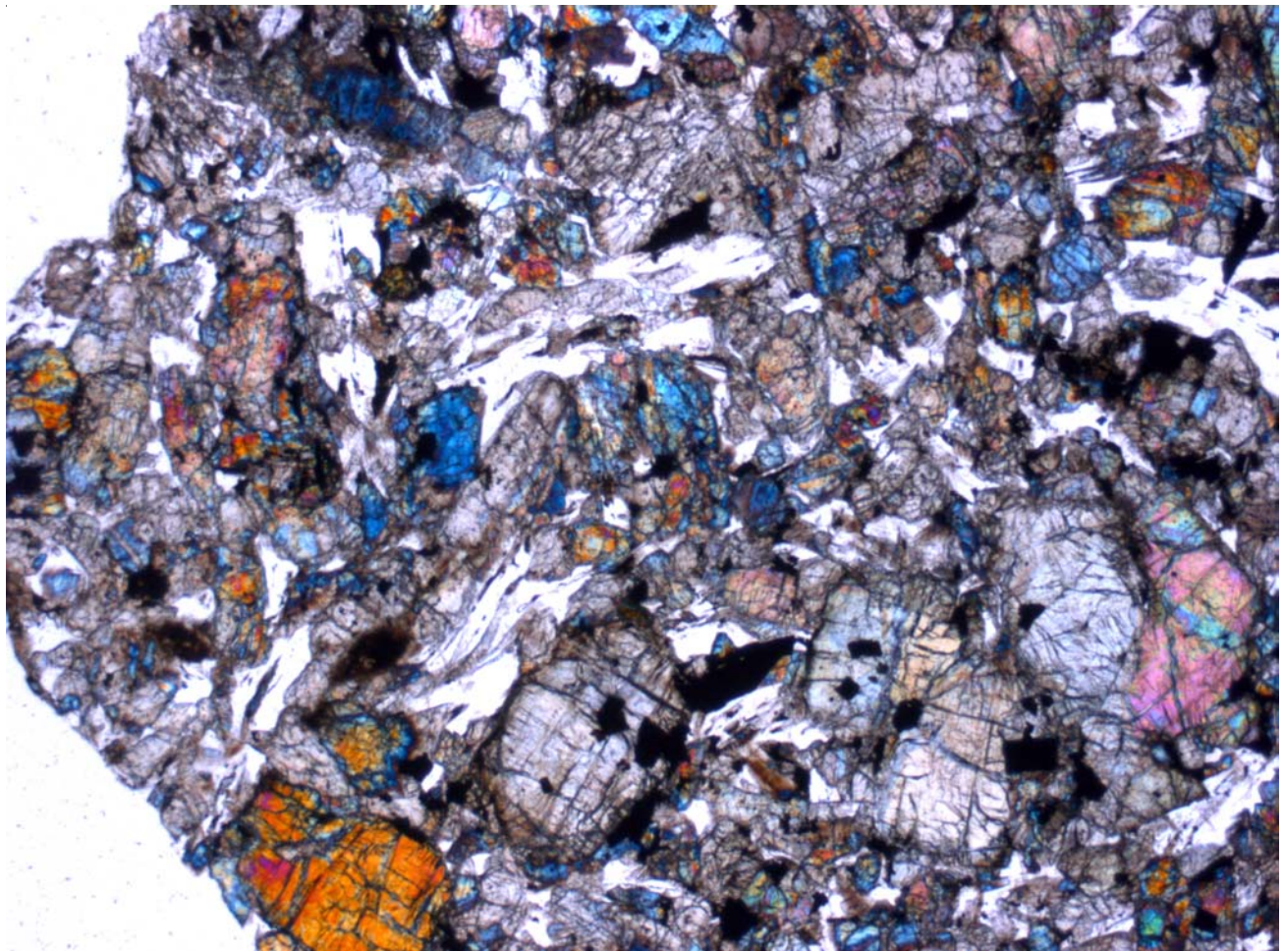
**Figure 4:** Chemical composition of olivine and pyroxene in Tissint meteorite (Irving et al. 2012).

### **Mineralogy**

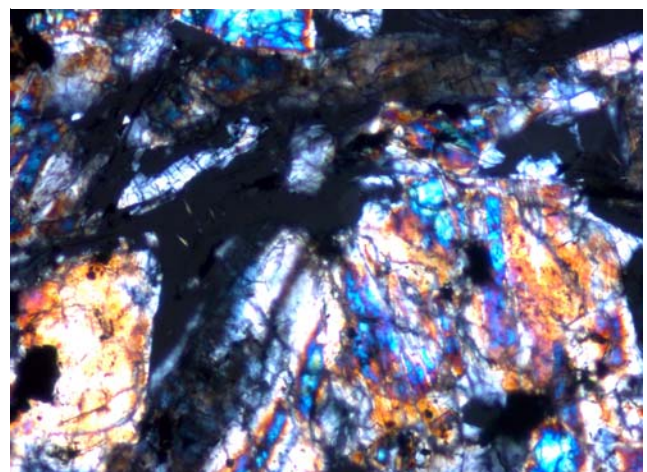
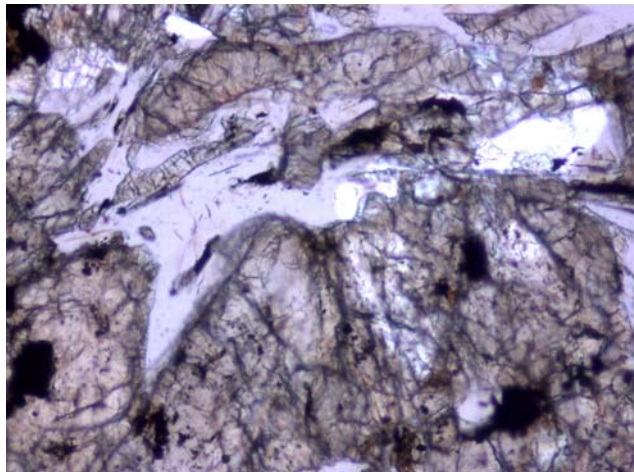
**Olivine:** Hsu et al. (2012) found the cores of olivine megacrysts were Fo<sub>81</sub> while the cores of olivine phenocrysts were Fo<sub>77</sub>.

**Pyroxene:** Irving et al. (2012) presented a pyroxene diagram (figure 4).

**Plagioclase:** All of the plagioclase has been converted to maskelynite. Hsu et al. (2012) reported plagioclase composition as An<sub>58-66</sub>.



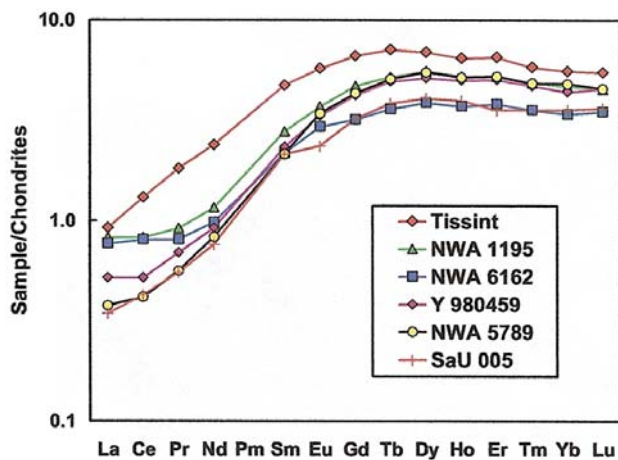
**Figure 3:** False-color photomicrograph with partially crossed Nicols by C Meyer of thin section of Tissint provided by Carl Agee. This photo is 2 mm across.



**Figure 5:** Photomicrographs of Tissint showing plagioclase has been shocked to isotropic maskelynite (Meyer of Agee's TS).

**Sulfide:** The sulfide in Tissint is pyrrhottite (Gattacceca et al. 2012).

**Phosphate:** Hsu et al. (2012) and Sanborn et al. (2012) have identified merrillite.



**Figure 6:** Normalized rare-earth-element diagram for depleted shergottites with pattern for Tissint (Irving et al. 2012).

**Oxides:** Magnetic studies have identified magnetite, pyrrhotite, chromite and ilmenite (Hoffmann et al. 2012; Gattacceca et al. 2012).

### **Chemistry**

Irving et al. (2012) determined the trace element composition (preliminary; table 1, figure 6). It is a “depleted” shergottite.

### **Radiogenic age dating**

Brennecka et al (2012) reported the Sm-Nd and Rb-Sr isotope systematics, finding that Tissint was formed from a mantle source extremely depleted in Sm and Rb. They reported a preliminary age of  $596 \pm 23$  m.y. – which is kind of old for a Martian shergottite.

### **Cosmogenic isotopes and exposure ages**

Nishiizumi et al. (2012) determined the cosmic exposure age as 1.1 m.y. using  $^{10}\text{Be}$ .

### **Other Studies**

Steele et al. (2012) reported on inorganic carbon compounds – *if there are such things*.

### **Processing**

There appear to have been 3 chunks of Tissint on the order of 1 kg each. One chunk made it to the British Museum (now called The Natural History Museum). There are so many other small pieces one wonders if they are all Tissint – you know, of course, that Morocco is blanketed with shergottites!



**Figure 7:** Location of strewnfield in Morocco - see Ibhi 2012.

### **References for Tissint**

**Table 1. Chemical composition of Tissint.***Preliminary*

<i>reference</i>	Irving12	
<i>weight</i>		
SiO <sub>2</sub> %		
TiO <sub>2</sub>		
Al <sub>2</sub> O <sub>3</sub>		
FeO		
MnO		
MgO		
CaO		
Na <sub>2</sub> O		
K <sub>2</sub> O		
P <sub>2</sub> O <sub>5</sub>		
S %		
<i>sum</i>		
Sc ppm		
V		
Cr		
Co	45	(a)
Ni		
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb	0.36	(a)
Sr		
Y		
Zr		
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba		
La	0.29	(a)
Ce	1.07	(a)
Pr	0.22	(a)
Nd	1.47	(a)
Sm	0.95	(a)
Eu	0.44	(a)
Gd	1.77	(a)
Tb	0.35	(a)
Dy	2.29	(a)
Ho	0.49	(a)
Er	1.42	(a)
Tm	0.19	(a)
Yb	1.23	(a)
Lu	0.18	(a)
Hf	0.96	(a)
Ta		
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm		
U ppm		
<i>technique</i>	(a) ICP-MS	

