# The set of high temperature- pressure minerals in the shocked meteorites of Shahdad

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## ABSTRACT

*In this study, 3 pieces of meteorites KM97003, KM97007, KM97008 of chondrite type H4, which are strongly shocked and contain high pressure polymorphs of main minerals (olivine, pyroxene, feldspar and quartz), in order to investigate high temperature-pressure minerals which is created during the sudden transformations caused by the shock to the meteorite, has been studied. The size of these high-pressure minerals is micron to less than micron and they are inside or in the vicinity of shock-induced melt veins and melt cavities in chondrite. The purpose of this article is to review and summarize the findings related to high pressure natural minerals in Shahdad shocked meteorites.*

***Key words:*** High pressure polymorphs, Melt veins, Chondrite type $H_4$, Meteorites**.**

## 1.*INTRODUCTION*

*Shock, or impact, materials hosted within meteorites have for several decades provided the only laboratory samples through which shock-induced solid-state transformations and processes occurring at the extreme temperatures and pressures experienced during a meteorite-producing fall can be investigated. Such studies of shock features that have survived quench, annealing, oxidation, and other modern laboratory processes in the lithic blocks and fragments within impact melt breccias are of unique value [1].*

*Raman spectroscopy is a technique that is related to molecular identification of molecules which has found various applications in different research fields. Spectroscopy Raman able to recognise the chemical structure of the sample and identify the elements in it, which is done by measuring molecular vibrations. In the same direction, three pieces of chondrite meteorites $H_4$ is sent to the laboratory of University Shahid Beheshti (located in Tehran) was sent to perform Raman analysis.*

### 1.1 High pressure polymorphs

*In this study, high pressure polymorphs are the main components of the main minerals the usual like low calcium pyroxene, plagioclaz and chromite (Table 1). They are often inside or around another minerals, and consists some melted texture (are caused by shock) [2]. Noticing the table pressure range of most chondrites $H_4$ is 3-7 GPa (Table 2). The presence of these minerals shows two types of formation mechanisms: (1) transformation of host rock minerals into polycrystalline single mineral grains at high pressure in the solid state (2) the recrystallization of chondritic melt or a single mineral under high pressure, based on the experimentally determined phase relationships, the pressure of their formation is limited to the pressure range of ~25 Gpa. Thetextural, crystallographic and chemical*

*characteristics of high-pressure minerals provide clues about the impact events of the meteorite parent bodies in the Shahdad chondrites (Figure 1) [3].*

### 1.2 Determining the type of melting resulting from shock chondrites $H_4$

*Increasing the pressure and temperature, olivin is changed (α-[Mg, Fe]$_2SiO_4$) to phase β, with a modified structure of the spinel or its phase r [4]. On the other hand, β- $Mg_2SiO_4$ and β- $Fe_2SiO_4$ is part of wadsleyite [2] [5]. More over, asimovit [2] [6] and r -$Mg_2SiO_4$, r -$Fe_2SiO_4$ ringwoodite [2] [7] and ahrensite [2] [8]. Of course, it is note worthy that individual mineral species cannot be accurately studied only by Raman spectroscopy. The highest composition of phyllite (Fa) in most of the olivines is in balanced and unbalanced ordinary chondrites, less than 50 % in the mole [2] [9].*

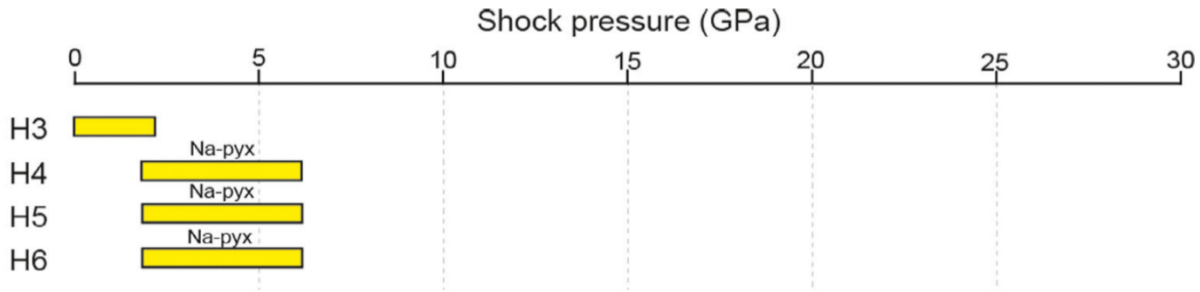
*Therefore, in this study, minerals like wadsleyite and ringwoodite only for high pressure polymorphs of (Mg, Fe)$_2SiO_4$ have been used. Low calcium pyroxenes ([Mg, Fe] $SiO_3$) is also transformed into high temperature- pressure polymorphs by increasing temperature and pressure factors. $MgSiO_3$ and $FeSiO_3$ is subsequently with Ilmenite, akimotoite [2] [10] or hemleyite [11]. Similarly, $MgSiO_3$ and $FeSiO_3$ have perovskite and bridgmanite structure [12] or hiroseite structure [11]. These are two minerals that are mentioned can not be done by spectroscopy alone Raman identified. In the first microscopic observations, 3 chondrite $H_4$ that have the melting caused by the shock dropped that networks and all kinds of lines caused by shock melting in the darkness $H_4$. It can be seen and the vaselite has replaced the melt resulting from the shock of the olivine due to the impact with the earth (Figure 1).*

**Table 1.** Frequency of high pressure polymorphs [2]

| | Abundance (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quenched melt | | | | Fragment | | | | | | | |
| Type | Wds | Rwd | Maj-$Pyr_{ss}$ | Aki | Wds | Rwd | Maj | Aki | Na-Pyx | Lin | Coe | Tui |
| H3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| H4 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 31 | 0 | 6 | 0 |
| H5 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 19 | 0 | 0 | 5 |
| H6 | 11 | 6 | 11 | 6 | 11 | 11 | 6 | 11 | 22 | 11 | 0 | 0 |
| L3 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 8 | 0 |
| L4 | 6 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 75 | 0 | 19 | 0 |
| L5 | 25 | 0 | 29 | 0 | 36 | 0 | 14 | 0 | 93 | 0 | 14 | 0 |
| L6 | 45 | 30 | 40 | 10 | 40 | 55 | 25 | 25 | 65 | 35 | 0 | 5 |
| LL3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 20 | 0 |
| LL4 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 64 | 0 | 9 | 0 |
| LL5 | 7 | 0 | 7 | 0 | 7 | 0 | 0 | 0 | 87 | 0 | 7 | 0 |
| LL6 | 25 | 0 | 0 | 0 | 38 | 6 | 0 | 0 | 81 | 6 | 19 | 0 |

Note: Wds = wadsleyite; Rwd = ringwoodite; Maj = majorite; Aki = akimotoite; Maj-$Pyr_{ss}$ = majorite-pyrope solid-solution; Na-Pyx = Na-clinopyroxene; Lin = lingunite; Coe = coesite; Tui = tuite.

**Table 2.** The relationship between pressure on chondrite due to impact with the ground and petrologic types of chondrites and their minerals [3].



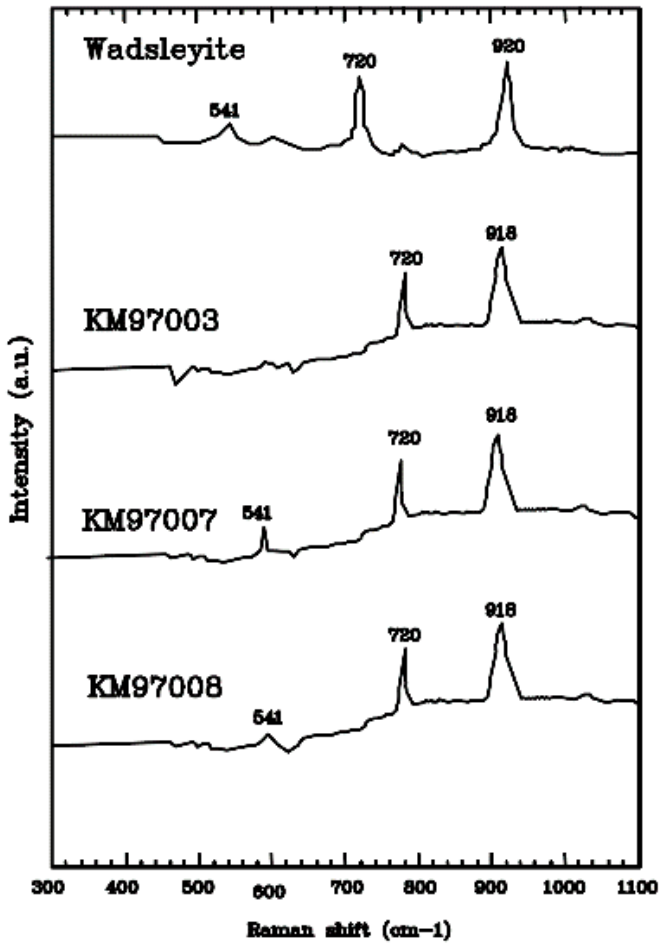



**Fig. 1.** Data comparison Raman Chondrites $H_4$ of Shahdad (KM97003, KM97007, KM97008) with chondrites Sahara and the presence of Vaselite on them [3].

*According to the said contents and the studies conducted by researchers such as Miyahara et al [2], and the data obtained from Raman and the investigations carried out on the meteorite fragments achieved from Shahdad, the samples were shocked during the collision with the earth's surface, what is more caused the appearance of high pressure- temperature minerals in this chondrite. Refering to Vaselite, which is formed during the change of the main mineral structure of meteorites such as olivine is possible.*

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