The abundant literature on SNC meteorites clearly shows that the understanding of the metamorphic record of these objects is not only critical for the knowledge of their history but also for the identification of their provenance (source and mechanism). The controversial interpretations of both source and dynamics of SNC illustrate the need for further investigation of their shock record. With that respect, the present paper concludes a study initiated at NASA JSC in 1983 (1), then continued at CARME, owing to an INSU grant (2).

The following materials have been studied: several sets of Shergott samples; Zagami; ALHA 77005; EETA 79001 (both lithologies); two sets of Nakhla samples; and Chassigny. Polished thin and thick sections have been studied by combined microanalysis techniques, including optical and scanning electron microscopy, EDX and electron microprobe, and a microreflectometry technique adapted for direct and non destructive micromeasurement of refractive index (RI) of glass and crystal (3).

The study is based on the evaluation and the comparison of the shock record obtained from distinct indicators within a same rock, and from one rock to another. These indicators are experimentally calibrated criteria based on i) qualitative petrology; ii). the pressure/composition dependent values of RI of plagioclaseic phases.

Shergotty, Zagami and EETA 79001 are similar in term of mineral and rock shock feature. They exhibit pronounced mosaicism of pyroxene: P > 30 GPa (4), essentially complete transformation of plagioclase to diaplectic glass: P > 33-36 GPa (5), essentially no (or limited) plagioclase and/or bulk rock melting: P < 45 GPa (5). ALHA 77005 shows melt pockets and vesicular plagioclase glass coexisting with diaplectic glass, indicating a higher shock level than in the 3 other Shergottites (P > 45 GPa).

Nakhla and Chassigny both show definite and quite similar evidence of mineral and rock shock features. A significant portion of ferromagnesian silicates presents severe fracturing and mosaicism which compares to that of the shergottites, suggesting a shock pressure in the range 20 to 40 GPa (4). Local strong fracturing and brecciation as well as shock veins are present. Unlike in shergottites, Nakhla and Chassigny interstitial feldspar phases are not converted to maskelynite and are polycrystalline. The laths are deformed and show ondulose extinction. The apparent shock level recorded in feldspars is less than 15-20 GPa according to these features. The polycrystalline character of the interstitial phases, the detail of the mineral grain boundaries, injected intragranular fractures, sulfide droplets... may indicate localized melting in Chassigny and Nakhla.

Figure 1 gives the RI/composition/pressure data obtained. The 45 GPa estimate for ALHA 77005 plagioclase glasses and the 34 GPa fit of both EETA 79001 lithologies are in good agreement with the qualitative estimates based on petrography. Unsensitive to weak shock, RI data of feldspar give estimates in the range 0-15 GPa for Chassigny and Nakhla, which are consistent with the birefringent character of these minerals.

Within the RI/An/P space, the Shergotty data plot on a 29 ± 1 GPa isograde. The Zagami data plot on a 27 ± 1 GPa isograde. These estimates are significantly lower than those deduced from the petrography. RI of Shergotty and Zagami diaplectic glasses are higher than those found in the whole set of experimentally and naturally shocked terrestrial material of the same composition. This anomalously as been previously noticed (5,7,
and is responsible of the shift of the RI/composition pressure estimates toward low values. The most plausible explanation is that Shergotty and Zagami have undergone a second shock after that which transformed the plagioclase into diaplectic glass. This interpretation is supported by reshocking experiments of (9) from which the conditions of the second shock can be deduced ($P = 12 \pm 2$ GPa or $22 \pm 1$ GPa, owing to the bell shape of the calibration curve).

Nakhla and Chassigny data can either be interpreted as significant of a relatively mild shock in the order of less than 20 GPa, an uneven distribution of energy, and/or differential behavior of the material being responsible for "local strong effects". Alternatively the data could be interpreted as the result of a relatively strong shock responsible for local melting ($P$ in the order of 35 to 45 GPa) followed by either slow cooling or subsequent thermal metamorphism resulting in the recrystallisation of feldspar phases, then followed by a weak shock ($P < 15$ GPa) responsible of the deformation in these feldspars.

The similarities, differences and complexity of the metamorphic record in SNC will be introduced and discussed in the various interpretations of dynamics, exposure ages and provenance of these objects.

REFERENCES: