FORMATION OF FE-NI PARTICLES BY IMPACT PROCESS. Y. Miura , Y. Uedo, and M. Kedves. Fculty of Science, Yamaguchi University, Yoshida, Yamaguchi, 753-8512, Japan.

Introduction: Characteristic indicator of impact event in rocks and minerals can be summarized as follows: a) Siderophile-element anomalies of Fe, Ni, Pt, Ir and Os elements. Bulk chemical compositions equivalent to compositions of mixed local bedrock types. b) Shocked quartz or lechatelierite of glassy states.

Among them glassy rocks and minerals are easily changed by increased temperature of
crustal activity after impact. In fact, it is very difficult to find shocked glassy rocks in active volcanic islands. Bulk compositions are possibly found in active crustal movement.

On the other hand, special elements of impact process can be found in siderophile elements because almost all meteorites contain siderophile elements which mainly can be found at deeper place of the planet Earth as follows. Major amount of siderophile lelemetmst: Fe and Ni (and Co)Manor or trace amounts of siderophile elements: Pt, Ir, Os etc. [1,2]

From Apollo lunar rock data, anomalies of siderophile elements are found in Ni, Au, and Ir, and mainly on lunar highland of breccias rocks (compared with mare basalt of igneous rocks).

Therefore, the followings are main purpose in this paper:
a) To make data-base of lunar and asteroid surface-materials from the planet Earth (in this case, Mien, Ries and Takamatsu craters).
b) To make clear characteristics and main source of Ni and Fe-Ni particles on the surfaces of Earth, the Moon, Mars and Asteroids. c)To make report of new particles of Ni (within 50 micron in size).

Fe-Ni elements: Fe-Ni minerals are found in metal phases of meteorites as follows: Kamacite, taenite and tetrataenite as 'original" Fe-Ni metal phases. End members of Fe and Ni element are difficult to find in original meteorites. If this metal is found in the samples with Fe-Ni particles, this means that it mixes with 'second" product of impact process.

Fe element: There is Fe particle in many types of lunar rocks and terrestrial rocks, which is considered to be formed as follows:

Weathering from Fe-bearing rocks of granites,
Impact process of Fe-bearing rocks. In order to decide the source of Fe-grains, it requires more information of occurrence and compositions of the rocks and minerals.

Ni element: Characteristics of Ni element is summarized as follows:
a) There is no particle data of Ni because of bulk compositions are very tiny grains (less than micro-meter) by electron-microscopy on the Earth.
b) On the lunar rocks, thin veins of Ni metal is found in basalt, 12002 and 12004 ,associated with fractures. Metallic Ni foils (with yellowish hue and high reflectivity) of a few micrometers thick surrounded by glassy fragments, are found in fine samples of 12003,17. Lunar Ni is pure Ni, with Fe (2-5%) and Co (0.5%). Morphology of Ni particles is considered to be impact origin.
c) If we can see more in details, Ni element formed from impact process can be found in terrestrial rocks. This is the main reason to discuss in this paper. Ionic potential is very high (Ni:18.2keV), which indicates that Ni easily forms sulfide minerals. In fact almost all Ni can be found as its sulfide minerals. Ni-and Fe-bearing minerals are FeS, NiS, NiAs2, CuFeS, and CuFe2S3. This minerals can be found at the Sudbury, Canada (60kmx25kmx3km) as sulfide matt (Cu:1.29%,Ni:1.62%) which is transported from impact projectiles. If there is also sulfur souce in meteorite, we can find also Ni sulfide in impact process which is easily misunderstand that Ni-sulfide is formed by magmatic process only in crustal activity. Ni in ultra-basic rocks of metamorphic belts are found in weathered serpentine minerals, (Mg,Fe)6Si4O10(OH)8, from olivine minerals of (Mg,Fe)2SiO4, as awaruite FeNi3 minerals. Such Ni particles can be found in New Caledonia as garnierite silicate minerals.

Impact experiment of Ni-rich particles : This experimental results are reported by previous proceeding of ISAS Lunar and Planetary Symposium, that Fe-Ni particles (less than 6%Ni) of kamacite metals in the Barringer iron meteorite have been evaporated, melted and solidified to form Ni-rich particles of of 49%Ni. This suggested the following impact process : Impact reaction is Vapor-Liquid-Solid (VLS) reaction, which is separated observed in the terrestrial rocks of volcanic process. End-member of Fe-Ni metals , Ni or Fe, can be obtained by artificial impact process. Ni particles found in lunar rocks are the same process of impact.

The reason why Ni particles cannot found in meteorites fallen to the Earth, is probably,difficulty to remain as tiny Ni-particles (during impact or firing of flight). In fact, there is no report on Ni on meteorites, and very difficult to find Ni particles in impact brecciated rocks on impact craters.

Ni-rich particles in craters: The Mien suevite , Sweden, contains Fe-Ni-S minerals (6%Ni). The Ries suevite, Otting, Germany, reveals Fe-Ni-Cu (31%Ni).

From the Miura (Kagawa-Takamatsu) crater, there are wide variations of the following Fe-Ni particles[1,2]:
a) Fe particle: pure iron. This is observed all rocks in Takamatsu crater, Yashima, and Koshikidai, Kagawa, and Maji, Shimane.
b) Fe-Ni particle: We can observe only in Taka matsu crater sample: Fe-Ni (9%Ni, 17%Ni); Fe-Ni-Cu (13%Ni). Ni particle: We obtain Ni particle [1,2]: (20micron to 70micron in size) , and 94%Ni (0.2%Fe).

Summary: The followings are summary in this study:
a) Fe-Ni mixed minerals are found in natural impact crater and artificial impact experiments, where Ni –rich particles can be formed by impact process.
b)First report of Ni-rich particle (94%Ni) with 50 micron in size, is found all the surface and drilled core of 300m in depth at the Miura(Kagawa-Takamatsu) crater in Japan.
c) Source of Ni is also supported by fact that there is few sulfur and few Mg in silica-rich rocks of granites.

Therefore, Ni is formed by impact process and remained during zeolitization under low metamorphism in the buried impact crater, Japan.

References:[1] Miura Y. (1999): PIECE'99 Abstract paper volume, 51-53. [2] Miura Y. and Y.Uedo (2000): Invest.Earth, Ed.by Miura Y. (Japan), 1, 1-5, 8-13.