NEUTRON COMPUTED TOMOGRAPHY OF IRON METEORITES: A NON-DESTRUCTIVE STRUCTURAL CHARACTERIZATION. S. Caporali[1], F. Salvemini[2], N. Calisi[2], M. Morelli[3], D. Faggi[3], V. Moggi-Cecchi[4], R. Serra[5], G. Pratesi[6], [1]Dipartimento Ingegneria Industriale, Università degli Studi di Firenze, Via S. Marta 3, 50139 Firenze, Italy, e-mail: stefano.caporali@unifi.it, [2]Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation (ANSTO), Lucas Height, NSW 2234, Australia, [3] Fondazione Parsec - Museo di Scienze Planetarie, Via Galcianese, 20H, 59100 Prato Italy, [4]Museo di Storia Naturale-SMA, Università degli Studi di Firenze, Via G. La Pira 4, I-50121, Firenze, Italy, [5]Museo del Cielo e della Terra, Vicolo Baciadonne, 1, 40017 San Giovanni in Persiceto, Italy, Dipartimento, [6]IAPS-INAF, Via del Fosso del Cavaliere, 100, 00133 Roma, Italy

Introduction: Neutron Computed Tomography (NCT) enables, on the base of the different atomic attenuation capability, the reconstruction of the interior structure of an object without physically dissecting it. The much higher penetration capability of thermal neutrons, respect to traditional probes like X-rays, allows them to penetrate through dense materials such as metals. Therefore, NCT is currently widely adapted for the investigation of materials of industrial or cultural interest [1]. Recently, this technique has been also applied to the study of planetary science materials [2-5]. Here, we present a preliminary NCT investigation of iron meteorites.

Method and samples: The different attenuation capability (sum of neutron absorption and neutron scattering) of the elements constituting the samples, mainly iron and nickel, allows discerning different phases present within the sample interior from its computationally reconstructed 3D structure.

Table 1. Summary of the chemical and structural characteristics of the analyzed meteorites.

Meteorite Name	Country Found	Chemical group	Structural group
NWA 859	Morocco	**Ungrouped**	Plessitic octahedrite
Henbury	Australia	**IIIAB**	Medium Octahedrite
Twannberg	Switzerland	**IIG**	Hexahedrite to coarsest octahedrite
Boxhall	Australia	**Ungrouped**	
Cerro del Inca	Chile	**IIIF**	Fine to medium octahedrite
Mundrabilla	Australia	**IAB-Ung**	Medium octahedrite.
Odessa	United States	**IAB-MG**	Octahedrite
Morasko	Poland	**IAB-MG**	Coarse octahedrite
Toluca	Mexico	**IAB-sLL**	Coarse octahedrite,
Gibeon	Namibia	**IVA**	Fine octahedrite
Canyon Diablo	United States	**IAB-MG**	Coarse octahedrite,

Neutron computed tomographic (NCT) images were obtained at the Australian Nuclear Science and Technology Organisation (ANSTO, Lucas Heights Australia) with their Neutron Imaging Facility (DINGO beamline [6]). The system uses thermal neutrons (wavelength distribution centered on 1.8 Å) and the projection images are acquired using a combination of a 30 µm thick Gadox scintillation screen to convert the neutrons to visible light and a 15 Megapixel (5056 x 2968) IRIS CMOS sensor camera.

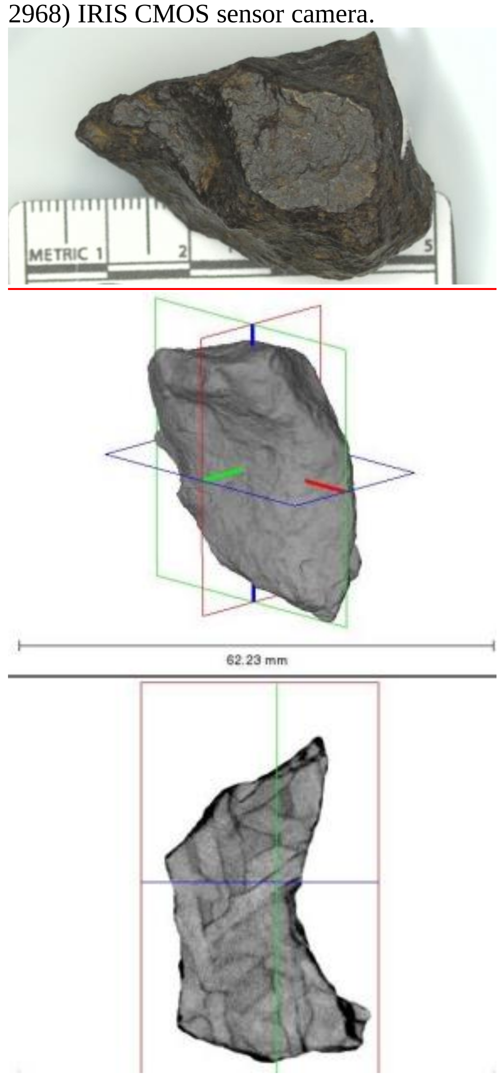

Figure 1. From top to down: picture of the Odessa meteorite sample, volume rendered NCT image and a CT slices through the meteorite.

Voxel resolution was 25×25×25 μm^3 and the obtained slices have been recomposed using AVIZO software. Table 1 summarizes the data of the investigated samples that were analyzed, as received.

Results and discussion: Our preliminary results show some of the possible application of NCT in analyzing iron meteorites. Figure 1 and figure 2 depicts images, volume rendering and reconstructed slices of two of the eleven investigated meteorites evidencing clear textural differences.

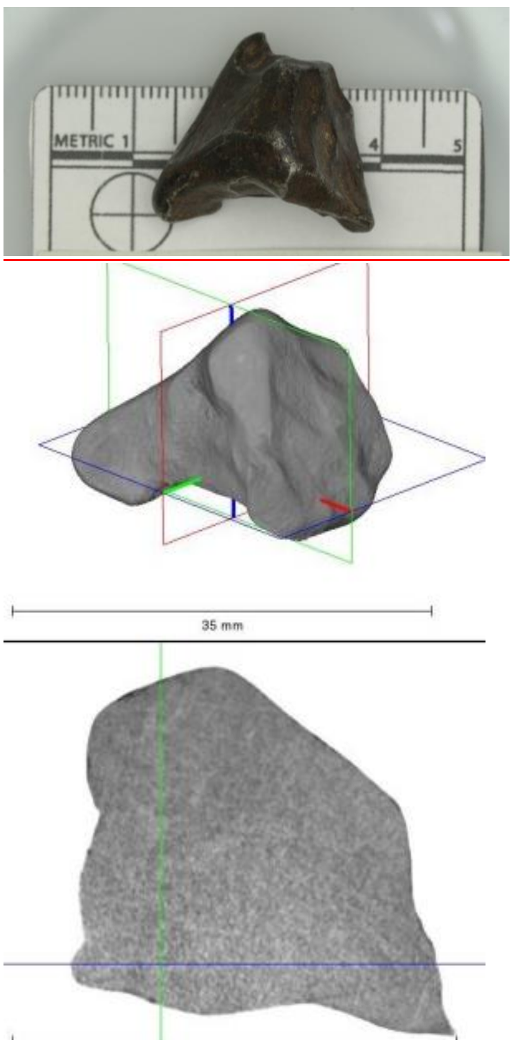

Figure 2. From top to down: picture of the sample, volume rendered NCT image and a CT slice through NWA 859 meteorite.

Odessa meteorite (figure1) is characterized by large iron crystals (Octahedrite) while NWA 859 (plessitic Octahedrite, figure 2) is characterized by a much finer structure.

Furthermore, NCT can also be applied to get some qualitative chemical data. In fact, the total linear attenuation coefficient (μ) describes the fraction of neutron beam that is absorbed, or scattered, per unit thickness of the sample material. How it is defined:

$$I(\lambda) = I_0(\lambda) e^{-\sum_i (\mu(\lambda) d)_i} \quad (1)$$

where $\mu(\lambda)$ is the total linear attenuation coefficient and d is the sample thickness for each isotope i. At the neutron wavelength λ, the total linear attenuation coefficient $\mu(\lambda)$ of an isotope is defined as:

$$\mu(\lambda) = \sigma_t(\lambda) \frac{\rho N_A}{M} \quad (2)$$

where $\sigma_t(\lambda)$ is the total cross-section for neutron abortion and scattering, ρ is the density, N_A is Avogadro's number and M is the atomic mass. Therefore, the histogram of a tomographic dataset represents the frequency distribution of μ. Figure 3 depicts such histogram, constituted by the eleven samples investigated, providing valuable cumulative information about the chemical nature of the samples.

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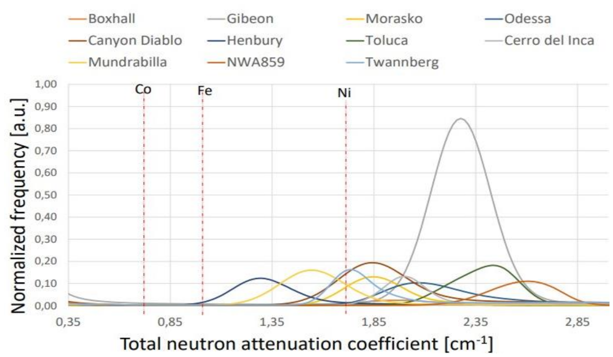

Figure 3. Histogram of the tomographic dataset of metallic meteorites investigated.

Acknowledgments: This work is supported by Regione Toscana under, POR FSE 2014-2020 programme, trought the project "ASSIEME-Structural and 3d analysis of metallic meteorites and multimedial database realization". We also wish to thank Museo del Cielo e della Terra, San Giovanni in Persiceto (BO) Italy, and Museo di Storia Naturale dell'Università di Firenze (FI), Italy for providing the samples studied.

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