Description and characterization of the Scalea ordinary chondrite, a new italian fall meteorite: V. Moggi-Cecchi[1], G. Pratesi[2,3], T. Cuppone[2], X. Shehaj[2,4,5], [1]Museo "La Specola" – Sistema Museale di Ateneo, Università di Firenze; email: vanni.moggicecchi@unifi.it, [2]Dipartimento di Scienze della Terra, Università degli Studi di Firenze, Firenze, Italy, [3]INAF-Istituto di Astrofisica e Planetologia Spaziali, Roma, Italy, [4]Agenzia Spaziale Italiana, Roma, Italy. [5]Dipartimento di Fisica, Università degli Studi di Trento, Trento, Italy.

Introduction: In Italy the recovery of fall meteorites is an extremely rare event due to unfavorable environmental conditions that do not allow long-term conservation of meteorites on the fall site. Moreover, systematic recovery campaigns for meteorite falls have never been organized in recent times on the Italian territory due to strong constains such as the presence of numerous urbanized, cultivated, wooded or mountain areas. The recent cases of the falls of Cavezzo and Matera meteorites is an exception: both these falls were monitored through the all-sky cameras of the Prisma network: in both cases a precise determination of the fall area allowed a relatively easy discovery of centimeter-sized fragments that permitted a complete characterization of the meteorites [1,2,3]..

The Scalea meteorite: A very interesting case is represented by the recent recovery of the Scalea meteorite. On September 11th, 2024 at 12.34 CET Mr. Maurizio Sassone, owner of a beach resort in the town of Scalea, Cosenza, Italy, while walking on the limestone shore, personally witnessed the fall of a stone a few meters away from him, exactly in the strip of land between the shoreline and the furnishings of his resort. He heard a loud whistle and a dull thud and immediately after he saw a couple of meters aside him a dark brown stone about 6x4x4 cm wide, with a small grey chip on top, in the center of a small crater, 30 cm-wide and 10 cm-deep (Figure 1). He made a detailed photographic report without removing the object and then collected the object and a small quantity of white sand from the surrounding area. After contacting one of the authors, he brought the stone to the Meteocert Laboratory of the University of Firenze where the investigations regarding its nature and its complete characterization were conducted.

General features: The suspected meteoritic origin of the stone was confirmed both at naked eye and at detailed stereoscopic microscope observations: the meteorite is a whole stone weighing 189g with a rounded and oriented shape and an external surface displaying an almost complete dark brown fusion crust with several small cracks; some parallel streaks are visible on one side, which appears ablated and partially remelted [4]; on this side can be observed remnants of a small barred olivine chondrule. On top of the meteorite there is a small chip displaying a pale grey, fine grained texture consisting of green and white

Figure 1: the fall site with the Scalea meteorite

Figure 2: photography of the main mass of Scalea

small crystals, with few metal spots (Figure 2) suggesting a chondritic nature [5]. No other chondrules have been detected on the surface but several cracks are visible at the stereoscopic microscope scale.

Small cavities of the surface contained traces of a white, fine grained powder, probably due to the impact with the seashore. The powder resulted to be consisting of calcite, thus confirming the provenance of the meteorite from the limestone fine-pebble beach where the stone fell and has been recovered. A fragment of the meteorite was extracted for characterization and classification. The meteorite was then cut into two pieces weighing 167 and 19 grams, respectively. The meteorite was submitted for approval to the NomCom of the Meteoritical Society and approved on October, 20th 2025 as L5 ordinary chondrite (fall), with the name Scalea [6]. The type specimen, weighing 19 g, one chip and one thin section are on deposit at Museo di Storia Naturale dell'Università di Firenze (Inventory# MSN-Fi 3751-I); Maurizio Sassone owns the main mass, now weighing 167 g;

Instruments and methods:

Optical microscopy was performed at the microscopy laboratory of the Sistema Museale di Ateneo, Università di Firenze, Italy, using an Axioscope 5 polarizing optical microscope equipped with Axiocam-HR camera. SEM-BSE images have been performed at the Centro di Servizi di Microscopia Elettronica e Microanalisi (MEMA) of the University of Firenze with a Zeiss EVO-40. Electron microprobe analyzer–wavelength dispersive spectrometry (EMPA-WDS) analyses have been performed at the Firenze laboratories of the IGG – CNR (National Council of Research) with a JEOL-JXA 8230 microprobe.

Textural features:

The thin section displays a brecciated texture with two different lithologies: the predominant one is consisting of a medium-grained aggregate of olivine and pyroxene crystals, with minor plagioclase, all ranging in size 100 to 300 µm. Scattered PP, POP and BO chondrules and chondrule fragments are visible (Figure 3).

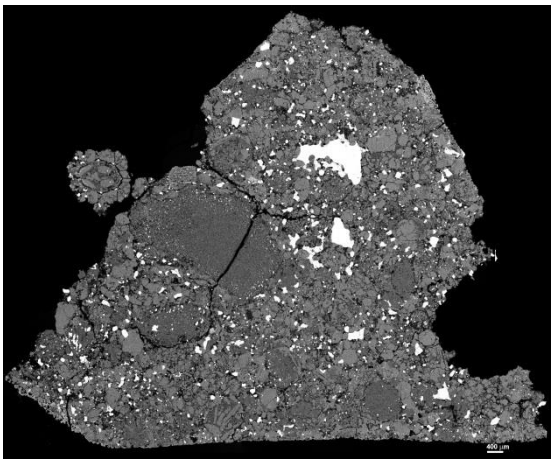

Figure 3: SEM-BSE photomosaic of the thin section of the meteorite displaying the chondritic texture; scale bar is 400 µm

The other one consists of few fine-grained chondrules and aggregates, mainly consisting of small low-Ca pyroxene and olivine grains, with minor high-Ca pyroxene and plagioclase, all with a mean grain size ranging 30-40 um (Figure 4). Opaque phases are represented by Si-free Fe,Ni alloys (kamacite, taenite and rare tetrataenite) and Cr- and Ni- free troilite in both lithologies, ranging in size 100-1000 µm in the coarse-grained and 10-80 µm in the fine-grained one. Chromite and apatite are present as accessory minerals, ranging in size 80-150 µm; sharp extinction of olivine indicates shock stage 1; both at the optical microscope and at the SEM scale no weathering is detected, since Fe,Ni alloys and troilite are unaltered, confirming null permanence on the ground.

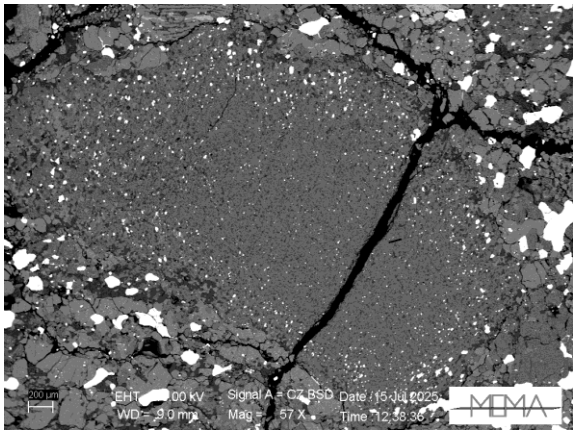

Figure 4: SEM-BSE image of the fine-grained lithology area; grey areas are silicates; white spots are opaques; scale bar is 200 µm

Minerochemical features:

For classification purposes, the general minerochemical features of the matrix and of selected phases were analyzed by EMPA on both the typical chondritic medium-grained texture and the fine grained one. Silicates are mainly consisting of olivine ($Fa_{24.9\pm0.3}Fo_{75.1\pm0.3}$; Fe/Mn = 53.31±0.3, N = 54); and Low-ca pyroxene ($Fs_{19.5\pm0.1}En_{79.0\pm0.1}Wo_{1.5\pm0.1}$; Fe/Mn = 30.22±0.2, N = 40) without remarkable differences between chondrules and matrix; rare diopside ($Fs_{8.0\pm0.1}En_{47.6\pm0.2}Wo_{43.1\pm0.2}$; N = 8), and an Ab-rich plagioclase ($An_{10.2}Or_{5.3}$, N = 17); Chromite: Cr_2O_3 = 55.3, FeO = 30.2, Al_2O_3 = 5.0, TiO_2 = 3.1, MgO = 3.0, V_2O_3 = 0.6, MnO = 0.4, ZnO = 0.3, all in Ox Wt.%; Apatite: CaO =52.3, P_2O_5 = 42.4, Na_2O = 0.5, FeO = 0.6, Cl = 5.5, F = 0.8, all in Ox Wt.%;

Discussion and conclusions

According to textural and compositional data the meteorite has been classified as a brecciated L5 ordinary chondrite, with medium degree of shock and medium degree of weathering [5,6].

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