The Meteorite Collection at the Natural History Museum in Vienna, and Selected Examples of Meteorite Impact Research

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The Natural History Museum (NHM) in Vienna is one of the most important museums of natural history in the world. Its collections date back to the year 1750, when the Emperor Franz Stephan of Lorraine (Franz I. Stephan) purchased (from Italy) what was then the largest and most famous collection of natural history specimens.

Meteorite Collection at NHM-Vienna

The meteorite collection of the Natural History Museum in Vienna, Austria, has the longest history of all comparable collections in the world. In the second half of the eighteenth century, soon after the foundation of the Imperial Natural History Cabinet in 1750, the Viennese curators began to collect meteorites. Although the first curators neither believed in the extraterrestrial origin nor accepted the – in several cases – written and witnessed histories of these allegedly “heavenly” stone and iron masses, they preserved them in the Natural History collection. Among the first acquisitions were the historical important meteorites Hraschina (Agram), Tabor, Krasnojarsk (Pallas Iron), and Eichstädt.

These and other well documented specimens from the Vienna collection were e.g., used by E.F.F. Chladni for his seminal treatises of 1794 and 1819, respectively. The central figure in the early history of the collection is Carl von Schreibers (1775–1852). His continued interest in meteorites laid the foundation for the Viennese collection to be of the historical and scientific importance it has today. Due to the efforts of Schreibers, who also is regarded as founder of meteoritic science in Vienna, and his successors, the Vienna collection became the largest and most extensive in the course of the nineteenth century.

Today, the NHM-Vienna he Natural History Museum of Vienna owns one of the largest meteorite collections in the world. With over 7,000 catalogued objects (which represent about 2,400 different meteorites), it appears to be the third largest meteorite collection in the world, after the Smithsonian National Museum of Natural History in Washington, D.C. (USA) (together with meteorites temporarily houses at NASA before entering the national collection), and the National Institute of Polar Research in Tokyo (Japan); both benefit from long-term, nationally-financed meteorite collection programs in Antarctica. In late 2012, the NHM, after a complete renovation and modernization, reopended its famous meteorite hall, which contains the world‘s largest meteorite display. Currently, there are over 1,100 meteorites on display (including 650 different meteorites, consisting of 300 falls and 350 finds).

New Meteorite Hall

The new hall includes the renovated central historic display cabinets, supplemented by new display cases and multimedia stations along the walls and in the window area. The historic show cases were carefully renovated and new cold LED lighting systems were introduced. On the front sides of each of the central historic show cases, interactive screens with informative slide shows lasting a few minutes were installed. The topics include: "Where do meteorites come from?", "Where and how do I find meteorites?" or "What are meteorites made of?", as well as information on stony meteorite, iron meteorites, the classification of meteorites, the history of meteorite research, and the history and importance of the Vienna meteorite collection. Here the interested visitors can obtain detailed background information that helps them to understand the importance and fascination of meteorites.

The thematic stations concentrate on different topics and try to engage the visitor in interactive displays. The stations include a unique display of all Austrian meteorites (including the Ischgl meteorite, which was added to the collections in 2012 and is only the 7th meteorite named after a location on the Austrian territory), almost 500-million-year old fossil meteorites from Sweden (another unique display), as well as stations on Mars and the Moon, complete with displays of Martian meteorites, lunar rocks, and lunar meteorites. Among the newest additions to the collection is the Tissint Martian meteorite, which was added to the collection in 2012). At another station allows the visitors can compare the weights of stony and iron meteorites, use a real and an electronic magnifying glass to peek deep into the interiors of meteorites and learn about their compositions and components, or a quiz in which visitors can see if they can tell real meteorites from “meteor-wrongs”.

One of the main attractions is a so-called “impact simulator”, in which visitors can chose from three different asteroid sizes (100 m, 1 km, 10 km) and two velocities (15 km/s and 30 km/s) with which these asteroids can hit the city of Vienna. This target was chosen because most visitors will be familiar with the size and extent of the city and its surroundings, to have a scale on which to place the destruction caused by the various asteroid impacts. The main message is that impacts are part of our cosmic environment and even if they can be destructive and dangerous, they are important to know about and fascinating to study.

The new displays are rounded off by one called “we are all made of star dust”. Here one of the other main results of the study of meteorites, besides learning about the when and how the Earth and the planetary system formed, is shown: how and where did the chemical elements form that make up all matter in the universe and the solar system (and also us humans). Through detailed mineralogical, chemical, and isotopic investigations of meteorites during the last 50 or 60 years it became clear that most elements form either in the interior of stars like our sun during nuclear fusion reactions, or during stellar explosions (such as supernova explosions).

So the new meteorite hall of the Natural History Museum Vienna preserves the classical systematic collection, but at the same times tries to engage the visitors by presenting them with many exciting things that we have learned from studying these otherwise inconspicuous-looking gray and brown stones. The many visitors that thronged to new exhibit and the positive comments received from colleagues at other museums seem to indicate that the path we took was the right one. A brand-new addition is the installation of a meteor radar station on the roof of the museum, with a life-feed to both the meteorite hall and the museum’s webpage, allowing visitors to see for themselves the constant bombardment that the Earth is being subjected to. In addition, a fireball camera is also installed on the roof of the museum, with images available on the museum webpage and being incorporated into the French FRIPON network.

Research at the NHM-Vienna

The main focus of the NHM-Vienna is, however, not mainly the public displays, but the curation and expansion of the large collections (in total, 30 million objects in collections representing anthropology, botany, zoology, prehistory, geology, paleontology, mineralogy, petrography, and others), and scientific research in all fields of the natural sciences as determined by the collections. The museum currently has about 350 people on staff, including over 60 scientists, and produces, as a result of a large number of mostly externally funded research projects, about 250 peer-reviewed publications per year.

Meteorite Impact Studies

One main topic of research at the NHM-Vienna, in cooperation with the University of Vienna and many international collaborators, deals with terrestrial impact crater studies. All bodies in the solar system that have solid surfaces are covered by craters. In contrast to many other planets and moons in the solar system, the recognition of impact craters on the Earth is difficult, because active geological and atmospheric processes on our planet tend to obscure or erase the impact record in geologically short time periods. The recognition of geological structures and ejecta layers on Earth as being of impact origin is not easy. Morphological and geophysical surveys are important for the recognition of anomalous subsurface structural features, which may be deeply eroded craters or impact structures entirely covered by post-impact sediments. However, definitive confirmation of an impact origin requires to obtain the information required for understanding the ultra-high strain rate, high-pressure, and high-temperature impact process.

This involves either shock metamorphic effects in minerals and rocks, and/or the presence of a meteoritic component in these rocks. In nature, shock metamorphic effects are uniquely characteristic of shock levels associated with hypervelocity impact. A wide variety of microscopic shock metamorphic effects have been identified. The most common ones include planar microdeformation features; optical mosaicism; changes in refractive index, birefringence, and optical axis angle; isotropization (e.g., formation of diaplectic glasses); and phase changes (high-pressure phases; melting). For the determination of the impact origin of a geological feature, the proper identification of either shock metamorphic evidence or the presence of extraterrestrial component is necessary. Impact cratering is a short-time, high-energy geological event in which conditions are created that exceed even the P-T conditions of nuclear bomb explosions. Research at the NHM includes the study of shock metamorphism, geochemical tracers of projectiles in impactites, the confirmation of terrestrial impact craters, drilling projects at large impact structures world-wide, shock processes in meteorites, the importance of impacts on the early Earth, and many other related topics. Of particular interest is the current study of a variety of spherule layers from South Africa and Australia for their chemical and isotopic composition, which, together with field geology, petrography and mineralogy, help to constrain the nature, size, and frequency of these early impactors. These and related topics will be discussed at the meeting.