EFFECTS OF MODERATE SIZE METEORITE IMPACT IN UNCONSOLIDATED SEDIMENTS - INTERDISCIPLINARY PROJECT ON "MORASKO" METEORITE IMPACT.

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Introduction: Impact cratering is probably the most ubiquitous geological process in the Solar System. However, most of the studies on impacts on Earth so far focus on the large impacts in hard rock substrate although smaller impacts in areas covered by unconsolidated sediments or weathering covers are much more frequent. The smaller impact craters the easier they are altered by various Earth surface processes. Thus, only few of them are relatively well known. The existing record of small, well-preserved crater structures, as the Morasko (Poland) crater field, give an unique opportunity to extend our knowledge on the relatively frequent small to medium size impacts and associated processes, including environmental effects.

Between 5,000 and 5,300 years ago the largest known iron meteorite shower in Central Europe took place nearby the present-day Morasko district of the city of Poznań, western Poland. Evidences obtained thus far indicates that the impact includes thousands of iron meteorite pieces distributed over an area of approx. 3 x 1 km; at least 7 meteorite impact craters formed with diameters of up to about 90 m. So far the studies focused on the meteorite properties and on confirmation of the impact origin of the depressions found in the area.

The aim of the project presented here is to extend the previous investigations and to undertake field and laboratory investigations, as well as to perform numerical modeling to reconstruct the Morasko impact and to assess its physical and environmental consequences. More specifically the objectives include: assessment of the age of the impact, of the volume, of the dispersal pattern and properties of the sediments ejected from the craters, estimation of the direction of the meteorite impact and the amount of released energy, identification of the sedimentological and geochemical signatures of the impact in the geological record, assessment of the environmental consequences and their duration, and testing of models for an impact in unconsolidated sediments.

Methods: To investigate this wide range of the impact effects, several approaches are followed, using mineralogical, geochemical, sedimentological, geophysical, micropaleontological methods, as well as numerical modeling. The project is divided into five work packages (Fig. 1), which focus on: WP1) proximal (within a few hundred meters from the craters) ejecta deposits and effects of the impact. This includes high-resolution geological mapping, investigation of potential impact signatures (deformations, shock quartz); WP2) distal (up to few km away from the craters) effects of the impacts, including the role of secondary processes. This part is based on the sedimentary record in nearby lakes and peat bogs; WP3) environmental effects of the impact based on analyses of phytoproxies from lakes and peatbogs; WP4) modeling of the impact using an advanced iSALE code modified for unconsolidated sediments, and WP5) data integration and project management.

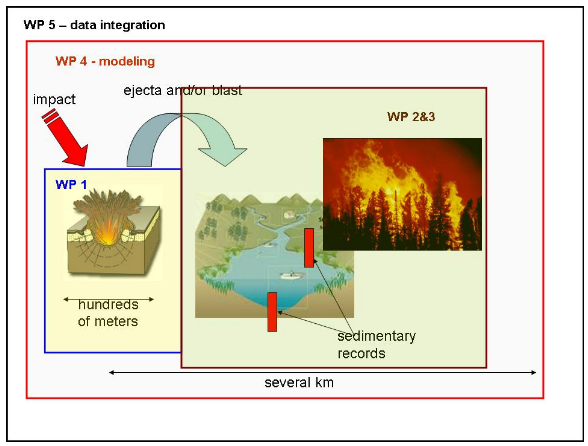

Figure 1. The outline of the workpackages (WPs) interactions in the project.

Preliminary results: The present abstract provides an overview of the major achievements and directions of study. Details on particular subtopics are presented on posters during the present workshop. They are focused on the ejecta blanket (Szokaluk et al.), mineralogy of local sediments and ejecta deposits (Duczmal-Czernikiewicz and Muszyński), record of the meteorite event in lake sediments (Pleskot et al.) and modeling of initial parameters of Morasko meteroid (Bronikowska et al.).

The detail studies of craters morphology and surrounding sediments allowed to reinterpret the original pre-impact morphology, which was not flat. The impact craters are formed in a slope of former morainic hill and due to that are characterised by distinct assymmetry. Reinvestigation of older data and several tens of new up to 9 m long sediment cores drilled around the biggest impact crater allowed to identify for the first time the impact ejecta layer. Because local geology is complex (glacitectonically deformed glacial sediments) the previous interpretations were not conclusive. During the ongoing study a paleosoil covered by ejecta blanket was found for the first time and provided a basis for the ejecta identification. The paleosoil ^{14}C ages are very close in time with the already known age of organic sediments infill of the crater and limit the age of the impact to c. 5300 - 5000 calibrated years BP. The ejecta is composed of sands, gravels, diamictons (e.g. glacial till) and clays. In some cases they are in reversed order in comparison to the underlying sediments (inversed stratigraphy). One of the sediment types, which is likely typical for the ejecta layer is diamiction with clasts of clay deposits. The ejecta distribution is complex and at the present stage it is confirmed only in sites with preserved and dated paleosoil horizon.

The investigations in 3 major lakes and several peatbogs around the area of the impact provided a new insight into Holocene paleoenvironmental development of the area. The peatbogs appeared mainly to develop after 2,500 years ago and thus appeared to be to young to record the impact. The lakes investigated are located about 2, 6 and 7.5 km from the craters. The clostest one is relatively shallow and so far the impact is likely recorded in it in a layer with redeposited gyttja (lake sediments) likely related to a seiche generated by the earthquake during the impact. The second lake, so far the best studied, revealed a continuus history of the last 16,000 years. In this period several "event" layers were found. One of them appeared to be close in time with the meteorite impact. The major disturbance is dated, however, to several hundreds of years before and is the most likely a result of early human occupation, which stopped around the time of the impact. It is marked by a signal in magnetic susceptibility of lake sediments, elevated Ni content, as well as the end of lake water eutrophication - likely related to human occupation. This scenario is also reflected in bioproxies (pollen analyses).

The collected data are also confronted with modeling. First efforts were focused on establishing the likely initial conditions of meteoroid. It is likely that the initial mass was between 500 and 1100 tons and the final impact velocities for crater-forming fragments varied from 1.5 to 7 km/s.

Future work: Although several questions have been already answered, several more were created during the present study. The current work is focused on mapping the ejecta deposits and finding new identification criteria. The mapping of the ejecta is associated with modeling of the ejecta formation. On one hand the groundtruth is necessary for the model, on the other hand the predictions are helpful in the fieldwork strategy. Meanwhile, several indicators of high pressure were found in association with pieces of dissintegrated bigger meteorite fragments. The very detail investigation of lake sediments (in submilimeter resolution) provides a chance to decipher the environmental results of the impact, which appears to be limited to few km from the craters and probably should be treated more as disturbance than a catastrophe from ecological point of view. Finally it is expected that integration of all the data will provide a new insight into a complex processes associated with moderate scale meteorite impact in unconsolidated sediments.

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