Three-dimensional representation of the Cornberg Geotope

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1. Working Area

The abandoned quarry Cornberg (Fig. 1) is an outstanding geotope in the Federal State of Hessen, Germany, as it is for geoscientific experts as well as for interested laymen of international importance since Permian deposits host footprints of Permian reptiles which worldwide are known from only a few more spots. Due to the great view into the palaeozoic Earth's history, the HLNUG chose this outcrop as hessian geotope of the year 2016.

In three particular outcrops, sediments of the Rotliegend and Zechstein are exposed. The Rotliegend sediments are composed of conglomerates at the base and the special facies "Cornberg Sandstone-Formation" on top. The fossil bearing Copper shale "Kupferschiefer" marks the beginning of the Zechstein transgression. It is the distinctive marker horizon indicating the marine transgression and the shift between terrestrial Rotliegend deposits towards marine Zechstein deposits, respectively. Due to its importance it is decided to digitally process this spot within the project described herein.

Fig. 1: Aerial Photo of the abandoned quarry Cornberg with the Cornberg Monastery in the foreground

2. Research Focus

In todays society, the general interest for geotopes is fading, with the number of visitors being generally low. To adopt new approaches in promoting such a spot and to get people interested in geology, the Hessian Agency for Nature Conservation, Environment and Geology (HLNUG) decided to start a pilot project in cooperation with the working group Geoinformation of the Technische Universität Darmstadt and the city of Cornberg which is in charge of the Hessian geotope of the year 2016.

By means of small unmanned aerial system (sUAS) based photogrammetry, a 3D-model of the outcrop has been created to serve as an advertising purpose in todays digital age. Furthermore it can be seen as the first project that will be featured in the soon to be created geological 3D-database of the HLNUG, including descriptive annotations in order to explain the main content that can be seen. The 3D-database can later on be used for research objectives in schools, universities and federal bureaus without the need of actually being in situ.

Fig. 2: DJI Inspire 1 PRO (X5) featuring a 16 MP on-board camera used for aerial photography

3. Methods and Equipment

Using a DJI Inspire 1 PRO (X5) (Fig. 2) camera drone featuring a 16 MP camera and additionally a Canon 16 MP DSLR, the area has been completely photographed from different angles and heights, followed by photogrammetric processing to develop a three-dimensional natural coloured model. Thereby the set of photos is connected and georeferenced via markers (Fig.3), which previously have been widely spread in the working area and measured with a differential GPS.

Finally the model consists of three zoom levels. One similar to a bird's eye perspective for a general overview of the whole area (Fig. 4). A second stage zooming into one of the three general outcrops of this geotope (Fig. 5) and the third giving impressions of 6 selected sections in high detail (Fig. 6).

Fig. 3: Distribution and measuring of markers (blue box) in the area to georeference the final model (symbol on marker is recognized by photogrammetric software)

4. Outcome and Outlook

The resulting first level overview model covers an area of about 54.000 m². The photogrammetric process results in a dense point cloud of more than 66 million points as well as a mesh consisting of 15 million faces. The second level models varies between 27 and 47 million points and 3 to 9 million faces. For the detailed third level models the amount of points lies between 15 and 34 million points, while the faces vary between 5 and 8 million faces covering in each case only a couple of square meters

Future work on this 3D-Model include digital mapping of the outcrops, the intersection with geological 3D-models as well as an comparison an combination with laserscan data to improve the applicability of small unmanned aerial system based photogrammetry in modern day geology.

Fig. 4: First level 3D-model of the entire geotope (view from west; yellow box indicates location of a second level model)

Fig. 5: Second level 3D-model of the most eastern outcrop (view from west; orange box indicates the location of a third level model)

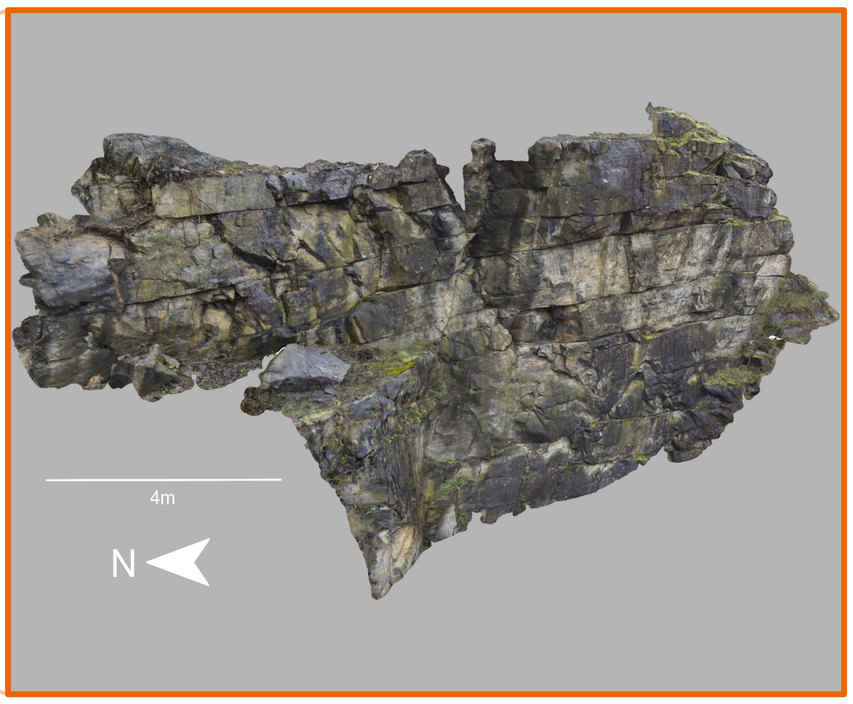

Fig. 6: Third level 3D-model showing the Cornberg Sandstone-Formation in detail (view from west)