Use of terrestrial laser scanning for the documentation of quaternary caves

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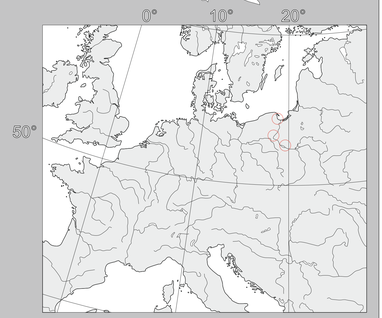


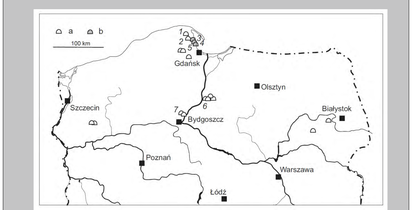
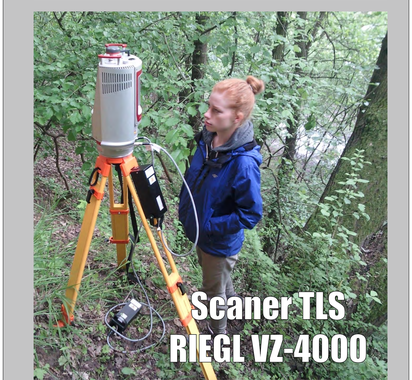
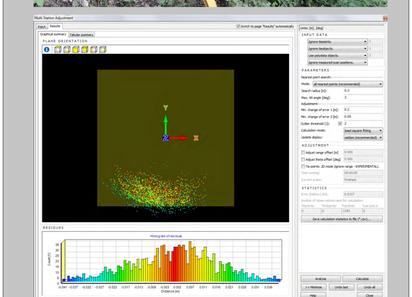
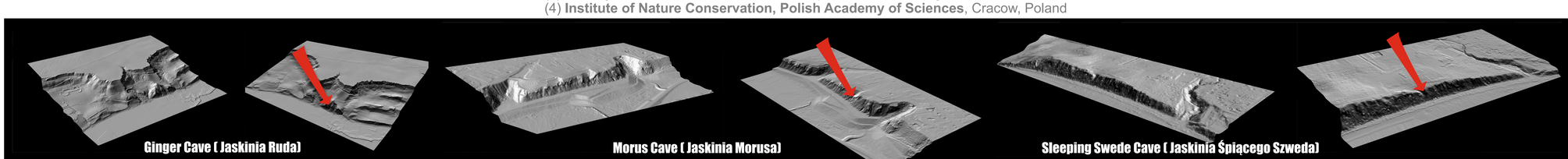


Fig. 1. Distribution of the caves and cavities in the Polish Lowlands. Explanations of symbols: A – caves in the Pleistocene calcareous sandstones, B – caves in other rocks. The sites (caves) mentioned in the text are numbered: 1 – Jaskinia w Mechowisie, 2 – Jaskinia w Polchowie, 3 – Jaskinia Śpiącego Szweda, 4 – Schron w Cypli, 5 – Jaskinia Goryla, 6 – Jaskinia pod Wierzbą and Jaskinia Kisnowa, 7 – Bujka I and Bujka II







Due to the nature of their occurrence and genesis, caves in the Polish Lowlands represent a peculiarity of geological heritage, unique on the European scale. They are developed in Quaternary deposits, mostly at the contact of slabs or irregular bodies of cemented glacial or glaciofluvial deposits: conglomerates and sandstones, with unconsolidated deposits, mostly sands, gravels and clays. So far, 20 such caves have been recorded in Polish Lowlands. Most caves are only several meters long, the largest one is over 60 m long. Regardless of their origins, the character of host rocks is the reason that processes leading to their formation are simultaneously the destroying processes. Thus, the studied caves, as well as other caves of this region, are unstable, gradually evolving objects. The changes taking place in them are continuous and intense enough, therefore the documentation of their shape with the greatest possible accuracy and resolution becomes crucial. Such possibility can provide the technique of laser scanning. In 2014 three caves, including one recently discovered, were scanned using the TLS. Measurements of caves and their surroundings were conducted in May and July 2014 with a scanner RIEGL VZ-4000. Point clouds from several scanner positions were combined using the module Multi Station Adjustment in the RiSCAN software. This module allows to connect point clouds from successive positions without any objects of reference. After the merger of point clouds from individual positions and their filtration, a collection of several million points was obtained. The number of points projected on the wall was over 20 000 per m2. The using of TLS enabled to present the morphometric features impossible to obtain using traditional methods. High density of the point clouds allows registering even small details on the cave walls, as well as monitoring leaching, falling, grinding and flaking processes taking place in them. Thus, the most important advantage of the TLS is the "visual protection" of these objects unstable in geological time-scale

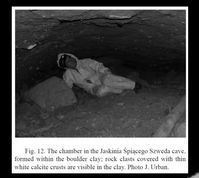


Fig. 12. The chamber in the Jaskinia Śpiącego Szweda cave, formed within the boulder clay; rock clasts covered with thin white calcite crusts are visible in the clay. Photo J. Urban.