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RIGHT: The Király-széke (King's throne) hive stone in a perspective aerial image (taken with a Nikon D3X, f=500 mm).

An innovative mapping company uses multispectral aerial surveys and 3D imaging to create maps of inaccessible rock formations in Szomolya, Hungary.

Hungarian Hive

By Gábor Bakó, Zsolt Molnár, and Eszter Góber

The hive stones are cone-shaped rock formations with ancient carvings on their sides. Located in a nature conservation area in the western part of the Szomolya municipality of Northeast Hungary, the hive stone group is made up of rhyolite tuff formed in the Miocene age during volcanic eruptions. The light grey pyroclastic rock is easy to carve, but it is also easily fragmented and crumbling. The destruction of rocks and the continuous abrasion of their surfaces justified recording the present status of these heritage sites (valuable for archaeological and ethnographical reasons) with high-precision mapping and three-dimensional morphological analysis.

In the hive stones' protected area of Szomolya, we have prepared a spatial information system for the Bükk National Park Directorate to encourage the site's protection. The spatial system also enables the periodical documentation of changes to the site, which may lead to an understanding of the damaging processes of the surface and the inside that has a high silicon dioxide content.

We conducted the aerial survey in the winter during our leaf-free period, after removing the invasive, nonnative vegetation, from 11:00 am to 12:00 pm. The visibility conditions were excellent. The recording was performed by the Hungarian-designed and -created Interspect IS4 digital calibrated aerial camera, which is able to make high-quality, 65% overlapping images during high-speed flight, so the whole working area is suitable for three-dimensional evaluation.

Despite the speed of 227 km/h (141 mph) and the 500 m (~446 yards) terrain clearance, we created 2-cm spatial resolution orthophotos of the hive stones and the surrounding forest. The images record the state of the land surface not only in normal light, but also in ultraviolet rays.

We found that by recording the forming material of the hive stones with UV aerial images, we were able to visually separate the material from its environment very well; these tuff outcrops almost glitter on the aerial map made in the deeply forested Bükk mountains. This method allows the rock outcrops to be detected in other inaccessible areas as well. Such surveys can be conducted faster, and the field crews will not be disturbing the nearby rare and protected bird breeding areas. (The aircraft scans the land surface at an altitude proven to be undetected by the nesting birds.)

The hive stones survey was made on a scale of 1:240, with one pixel representing a 2-cm-wide field stain. The photogrammetric process of the aerial images was made possible with a calibrated aerial camera with high-quality optical elements and a geodesic survey in the field. During the field work, a

LEFT: Since 2009 the Interspect Group has specialized in conservation, environmental, and water aerial surveys.

Stones

HiPer SR was used in real-time kinematic mode to deliver precise positioning accuracy. The acquisition of the latest calculation algorithms and the instrument were provided by Navicom Bt. We would also like to thank them for their continuous technical support. Without the latest Topcon Positioning System antenna technology, we could not have gotten a stable GPS signal in this area.

The field measurements took two days because the aim was to create orthophotos underlying the most accurate maps ever made of the area. This method creates a surface model and a high-precision two-dimensional orthophoto map.

Various methods have evolved for surface 3D modeling; our research group applies multispectral laser scanning

LEFT: The hive stones were captured using two types of ultraviolet light with an experimental camera.

Mysterious Hive Stones

In your mind's eye, fly with me to the Carpathian Valley and cast your eyes into Bükk National Park, near Szomolya in Northeast Hungary. Here you will find the curious and mysterious hive stones: conically shaped rock formations with unique niches whose origins and functions are the subject of many legends, speculation, and scientific assumptions.

One theory suggests early apiculture (bee-keeping) activities, which, coupled with the overall morphology of the formations, probably led to their common name: Hive Stones. Other theories suggest ancient sacrificial sites, religious carvings, and even the burial sites of Celtic tribes or Scythian-Hun-Hungarian heroes from the distant past.

There doesn't seem to be any consensus as to who carved these niches or their original function; the answers may remain shrouded in the mists of time.

Source: http://bnpi.hu/int/index.php?c=62 (the website of Bükk National Park, Hungary)

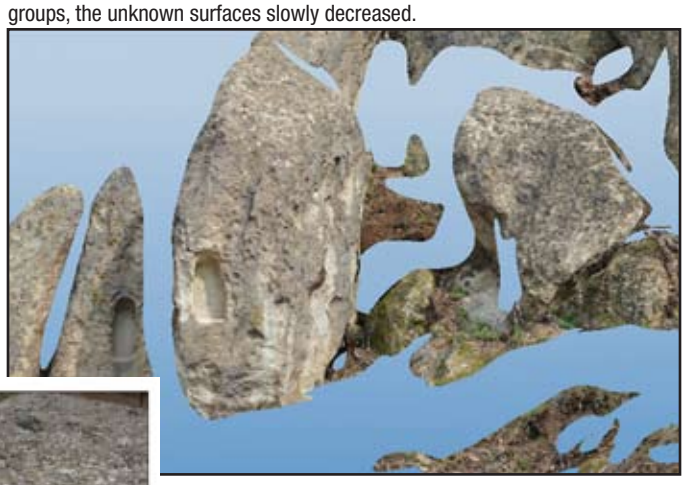
LEFT: An orthophoto map detail of perhaps the best-known hive stone group of Szomolya.

What is an orthophoto?

Orthophotos are high-quality aerial images taken by a calibrated aerial camera looking downward from the aircraft belly. Geometric distortions are deleted during the photogrammetric imaging process and from the perspective distortions of the central projection featured on each raw image, and of the elevation differences as well. The prepared orthophotos correctly represent the recorded land surface on the map by parallel projection (orthogonal projection). The aerial image map is made by unifying the orthophotos, i.e. mosaicing.

ABOVE: The crumbling surface of hive stones can be recorded in the 3D space.

ABOVE: As the authors surveyed one of the rock groups, the unknown surfaces slowly decreased.



and a photogrammetric process. According to our experience, for very detailed surveying of large objects, the laser application is faster and the photogrammetry is more accurate, while for smaller objects the reverse may be true. In all cases it is worthwhile to consider which technology to choose, separately. In the case of the hive stones, different wavelengths of light sources for aerial and field images facilitated our work. The project was very time-consuming considering that the area is inaccessible even with cranes, and climbing onto the rocks with ladders is prohibited. Therefore, for the time being we recorded in 3D parts of the site. We have made models of one hive stone, one niche, and a crumbling surface of a rock. To read more on this project, visit our website at www.interspect.net/index.php/Cegunk-es-eszkozparkunk/ceginformaciok.html

Gábor Bakó is a remote rensing specialist, leader of the Interspect Research Group, and a colleague at the Szent István University, Institute of Botany and Ecophysiology. He deals with designing aerial remote sensors, the implementation of aerial surveys, and photogrammetry.

Zsolt Molnár is technical manager of the Interspect Research Group. He leads the processing of aerial remote sensing and participates in aerial surveys.

Eszter Góber is head of the Interspect Research Group's archive and environmental information data storage.