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RED PLANET? RED RIVER! FIELD WORKS ON THE RED-MUD FLOOD POLLUTED MARCAL RIVERSIDE: pH MEASUREMENTS BY THE HUSAR-5 NXT-BASED ROVER MODEL OF THE SZÉCHENYI ISTVÁN HIGH SCHOOL, SOPRON, HUNGARY.

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Introduction: On October 4, 2010, heavy industrial catastrophe polluted the Marcal river in West-Hungary. The Red-mud sludge, the byproduct of the alumina production, poured from a containment pond because of the broken dike. The environmental pollution first appeared in the creeks and rivers in the vicinity of the alumina plant at Ajka. Earlier our group prepared pH measurement robotics on the HUSAR-5 rover therefore our idea was to carry out – a planetary analog type - field works with the rover on the polluted region. The locality was about 100 kilometrs from our town, Sopron. We visited 3 times the region.

Field works: We selected 4 measuring localities far from the near vicinity of the flood source, (Fig. 1.) about 20-30 km-s from Ajka. We rebuilt the pH measurement instrument on the rover, took defending coveralls and travelled on the sites, shown on Fig. 1.

First field work: Mersevát, (village) bridgehead: Oct. 23. 2010. (green triangles)

Second field work: Boba, (village) bridgehead: Oct. 31. 2010. (orange triangle)

Third field work: Kamond, (village) bridgehead: Nov. 13. 2010. (violet triangle).

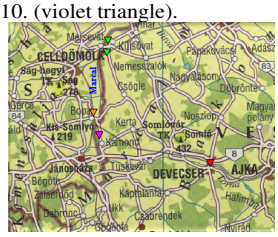

Fig. 1. The localities of the field works in the vicinity of Ajka: The town flood at Devecser is shown by the red triangle, other measuring sites are shown by colors.

Visual observations: At the lower stream region, 30 kilometers from the initial red-mud eruption, the river flooded its red sludge because of the overfill of gipsum. Gipsum was poured into the river in order to compensate the high pH value of the red mud sludge. Red mud cover on the shoreline was measured by our team by the Husar-5 rover. However, during our measuring first period the water of the river in the riverbed was also red because of the mud.

The Main instrument components of the rover: As shown in Fig. 2. the main components of the rover consist of the water tank and pump, the direction and control of Lego NXT, the indicator ribbon-arm, and the camera. During measuring mode the camera observes the surface in front of it and the pump pours water on that site (in order to solve soli components). In the next step the indicator-ribbon arm touch the wet surface. Rover returns back some wheel rotation unit and the indicator motor rolls the ribbon in order to become visible for the camera, which observes the color of the ribbon and the mission control compares it to the standerds. Then every units of the river return to the initial position and the rover is ready for the next measurement.

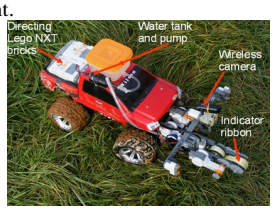

Fig. 2. The main components of the pH-measuring instrumentation of the Husar-5 rover.

Measurements at Mersevát: In our first field trip we stopped at the bridgehead at Mersevát village. There the grassy soil caused surprise: the grassy surface made impossible the movement of the rover (planned for rocky surface movements). Because in the pH measurements motion of the rover was important we wrote a new program for the ribbon arm rolling.

Fig. 3. Student Martians with the Husar-5 rover at Mersevát.

Then we moved some sludge on harder soil surface to carry out the first. Next problem was that the sludge glued onto the surface of the ribbon, so right now we

could not observe the changed color of the ribbon. But physics helped us by the capillarity of the ribbon material and therefore near to the sludge cover, (before and after the glued surface) the color changes were observed. So the program directed only a short rolling of the ribbon, before the camera observation.

Measurements at Boba: We conducted our second field trip (a week later) to Boba village, where the bridgehead seemed promisful for the measurements. Here we observed the white dust cover of the red-mud surface, which was the result of the gypsum remnant. The measurements seemed interesting if the effect of neutralization of the gypsum on the alkali mud had been successful, or not.

Fig. 4. Sludged red-mud surface with white gypsum remnant dust cover at Boba bridgehead measuring pont.

During the second field trip we visited another site at Kamond village. This place seemed excellent for the next measurements but we had to wait for drying up of the wet soil.

Measurements at Kamond: On the third field trip we returned to the Marcal river at Kamond. But the two weeks was not enough for the drying of the soil.

Fig. 5. Dry clay surface at Kamond measuring pont.

(Sinking surface stopped only at Decemeber 29, as reported by the news.) So at Kamond (Fig. 5.) from the sinking mud we moved the sludge onto a dryer surface in order to carry out the measurements. However, sunset approached, and there were interesting new insolation conditions. Therfore we showed the color standard to the camera to compare the ribbon color to it. Here we realized that for a good measurements the color changes of the ribbon and the color standard should be compared at the same solar insolation (parallel synchronous observation). The originally planned software comparison will not give true values.

Fig. 6. On site comparison of the standard and the ribbon color in an extraordinary sunlight condition az Kamond.

For control we carried home samples and repeated the masurements. (In all field trips we carried samples from the red-mud sludge.

Measurements at the Hing School, Sopron: In the informatics room of the high school we effused the sludge samples onto a nylon carpet, where the rover repeated the masurements. We could hold the color scale (we shall develop the measuring method by the holding the color scale standard) in hands in order to harry up the measuring steps, because we did not know if the sludge makes chemical reaction with the nylon carpet.

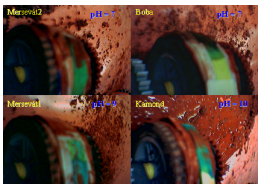

Fig. 7. The white dust clay was neutralized, however, the two riverside points showed alkaline red-mud values.

Summary: We reported about the 3 field works with the Husar-5 rover with pH measurements on the red-mud flood points in different regions along the Marcal river. We wanted to try how our experiment works in a real field. We learned very much how much to think in a real mission, and how important is a test on a planetary analog field. We also learned much from our failures, too. We learned that contrary to the planned and programmed works it is important to send new programs to the rover. The synchronous observation of the ribbon and the standard scale came to our mind in the field work, too. The experiment building and the field work surprises and problems gave great tasks for high school students, but they enjoyed the work and learned very much.

References:. Lang Á., Szalay K., Erdélyi S., Nickl I., Panyi T. G., Makk Á., Bérczi Sz. (2009): Experiment Measuring Chemistry (Ph) of the Soil on The Husar-5, NXT-Based Rover of the Széchenyi István High School, Sopron, Hungary. In Lunar and Planetary Science XXXX, Abstract #1235, LPI, Houston (CD-ROM).