Yamal Craters: State of Knowledge and Wished In-situ Investigations

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A unified compilation of the existing facts relating to the formation of " Yamal Craters" as well as a generalized description of the existing hypotheses of their creation is presented. At least 6 craters have been observed in or close to Yamal peninsula, located in permafrost areas. Almost all craters are located near gas and gas-condensate fields. Main morphological, spatial and geological features of "Yamal Craters"are analyzed and. published hypotheses of crater formation in the Arctic are clustered in three major groups:

1. The phenomena are formed by the external direct influence.
2. The phenomena are formed by the explosion of perennial frost mounds (bulgunnyakhs, pingos, hydrolaccoliths) formed due to freezing of paleo-taliks.
3. The phenomena are formed by the decomposition of gas hydrates, including the cases of the thermal effects from the top and from the bottom.

The following hypotheses evaluation criteria are used:

1. Hypothesis completeness
2. Confirmation by in-situ observation data or experiments
3. Self-consistency and amount of unsolved problems
4. The principal technical possibility to verify the hypothesis (accessibility of the objects, instrumentation and laboratory facilities)
5. The availability of ready-to-use physical and mathematical models in place describing the assumed driving process (fundamental knowledge of the process).

The considered hypotheses are founded at selected major process of crater formation. Most likely, all of them can be real in part and form the geological consequence. In the first stage the gas hydrate partial decomposition forms the horizon with gas bubbles at the depths 60 and 100 meters. In the second stage the heating from underwater taliks leads to bubbles' growing and the moving of its to the surface. The drainage of the lake converts the taliks to closed system with pressure growing.

Authors present a preliminary computation of stress and deformation with possible temperature regime to create such craters through overpressure and explosive process. The mechanical model takes into account the elliptical shape of the cave at 30 m depth with consequent pressure growing. The insignificant influence of climate change as a result of thermal field modeling was obtained.

Then, authors developed the field study program using remote and in-situ methods to assess the areal distribution and a possible danger of "Yamal Craters"for the oil and gas infrastructure and the environment. In practical terms, this study sheds more light on the regularities in the interaction of gases with surrounding permafrost and cold soils and also on the evolution of reservoir properties of deposits.

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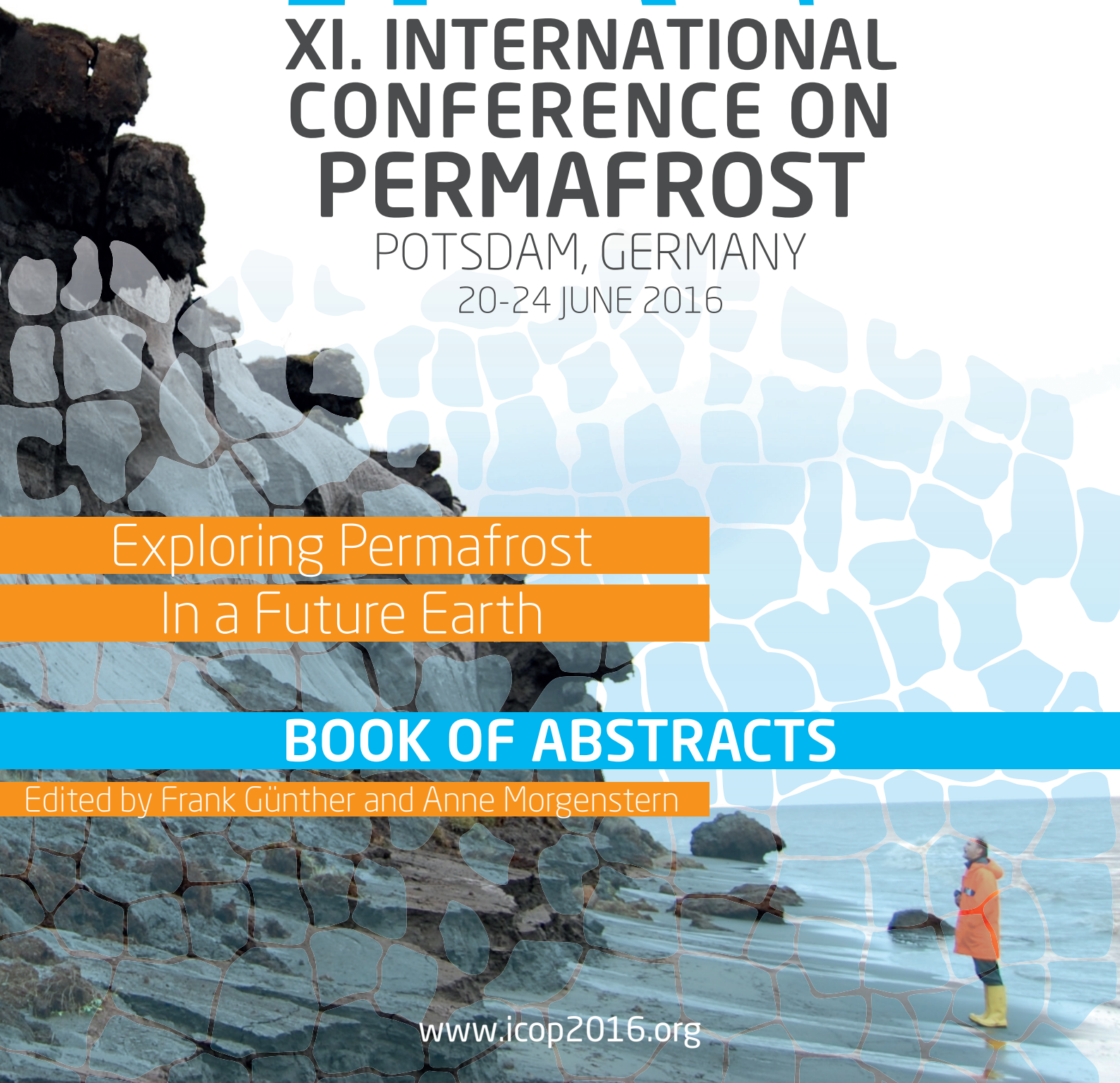

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