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Title: Diving at Extreme Altitude: Dive Planning and Execution During the 2006 High Lakes Science Expedition.

Authors: Morris, R  
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Abstract: The NASA Ames Diving Safety Office supported the successful diving operations of the 2006 High Lakes Project, HLP, in the 19,400 ft (5,913 m) crater lake of the Licancabur volcano in Bolivia. The HLP explores the limits of life in some of the highest lakes in the world located in the Andes at elevations up to 20,290'. The unique extreme diving environment required the development of new sets of diving standards, techniques, and technical diving protocols, early literature surveys having established the limitation of existing recreational, commercial, and military guidelines. Here we document the process of developing and executing a dive plan that enabled the dive team to achieve its scientific objectives while adhering to a high standard of safety. Key elements of the dive plan included use of closed-circuit oxygen rebreathers to mitigate combined altitude- and

decompression-related risks, derivation of new dive tables, a novel diver suspension system, and definition of protocols for a broad spectrum of dive-related activities and contingencies. The elements of the dive plan were tested individually and in combination, to the extent possible. A description of the two successful dives is given along with a summary of lessons learned and recommendations for future expeditions.

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