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ROBOMINERS - Resilient Bio-inspired Modular Robotic Miners

Balazs Bodo¹, **Luis Lopes**¹, Claudio Rossi², Giorgia Stasi³, Stephen Henley⁴, Vitor Correia⁵, Tobias Pinkse⁶, Alicja Kot-Niewiadomska⁷, Jussi Aaltonen⁸, Nikolaus Sifferlinger⁹, Nelson Cristo¹⁰, Norbert Zajzon¹¹, Gorazd Zibret¹², Janos Horvath¹³, and Maarja Kruusma¹⁴

¹La Palma Research Centre for Future Studies SL, Isla de La Palma, Canarias, Spain

²CAR UPM-CSIC, Madrid, Spain

³Geological Survey of Belgium - RBINS & University of Liège, Belgium

⁴Resources Computing International Ltd, Matlock, UK

⁵European Federation of Geologists, Brussels, Belgium

⁶K-UTECH AG Salt Technologies, Sondershausen, Germany

⁷Mineral and Energy Economy Research Institute, Polish Academy of Science, Krakow, Poland

⁸Tampere University, Faculty of Engineering and Natural Sciences, Tampere, Finland

⁹Department Mineral Resources Engineering, University of Leoben, Leoben, Austria

¹⁰Associação dos Recursos Minerais de Portugal, Lisboa, Portugal

¹¹University of Miskolc, Faculty of Earth Science and Engineering, Miskolc, Hungary

¹²Geological Survey of Slovenia, Ljubljana, Slovenia

¹³Geo-Montan Kft, Budapest, Hungary

¹⁴Center for Biorobotics, Tallinn University of Technology, Tallinn, Estonia

The Horizon 2020 ROBOMINERS project (Grant No. 820971) studies the development of an innovative technology for the exploitation of small and difficult to access mineral deposits. A bio-inspired reconfigurable robot with a modular nature will be the target of the research efforts. The goal is to develop a prototype that will be able to mine under different conditions, such as underground, underwater or above water. ROBOMINERS' innovative approach combines the creation of a new mining ecosystem with novel ideas from other sectors, particularly robotics. This covers both abandoned, currently flooded mines not accessible anymore for conventional mining techniques; or places that have formerly been explored, but whose exploitation was considered as uneconomic due to the small-size of deposits, or their difficulty to access.

The ROBOMINERS concept follows a 5-step approach: 1) Robot parts (modules) are sent underground via a borehole; 2) Self-assemble to form a fully functional robot; 3) Robot detects the ore deposit via sensing devices; 4) Using ad-hoc production devices, it produces slurry that is pumped out; 5) Ability to re-configure on-the-job.

Specifics include: 1) Construction of a fully functional modular robot miner prototype following a bioinspired design, capable of operating, navigating and performing selective mining; 2) Designing a mining ecosystem of expected future upstream/downstream raw materials processes via simulations, modelling and virtual prototyping; 3) Validation of all key functions of the robot-miner

to a "Technology Readiness Level" of TRL4; and 4) To use the prototypes to study and advance future research challenges concerning scalability, resilience, re-configurability, self-repair, collective behavior, operation in harsh environments, selective mining, production methods, as well as for the necessary converging technologies on an overall mining ecosystem level. These specific goals will deliver a new mining concept, proven in laboratory conditions, capable of changing the scenario of mineral exploitation.

Powered by a water hydraulic drivetrain and artificial muscles, the robot will have high power density and environmentally safe operation. Situational awareness and sensing will be provided by novel body sensors, such as artificial whiskers that will merge data in real-time with real-time production mineralogy sensors that, together with specific production tools, will enable selective mining, optimising the rate of production and selection between different production methods. The produced mineral concentrate slurry is pumped to the surface, where it will be processed. The waste slurry could then be returned to the mine where it will backfill mined-out areas.

ROBOMINERS will deliver proof of concept for the feasibility of this technology line, which can enable the EU to have access to mineral raw materials from otherwise inaccessible or uneconomic domestic sources, decreasing European dependency on imports from third-party sources, as envisaged by the raw materials policy. Laboratory experiments will confirm the Miner's key functions, such as modularity, configurability, selective mining ability, and resilience under a range of operating scenarios. The Prototype Miner will then be used to study and advance future research challenges concerning scalability, swarming behaviour and operation in harsh environments.