GLOBAL CHALLENGES FOR INNOVATION IN MINING INDUSTRIES

People have been digging in the ground for useful minerals for thousands of years. Mineral materials are the foundation of modern industrial society. As the global population grows and standards of living in emerging and developing countries rises, the demand for mineral products is increasing. Mining ensures that we have an adequate supply of the raw materials to produce all the components of modern life, and at competitive prices. Innovation is central to meeting the diverse challenges faced by the mining industry. It is critical for developing techniques for finding new deposits of minerals, enabling us to recover increasing amounts of minerals from the ground in a cost-effective manner, and ensuring it this is done in a way that is environmentally responsible. This book provides the first in-depth global analysis of the innovation ecosystem in the mining sector. This book is Open Access.

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Chief Economist, World Intellectual Property Organization

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FOREWORD

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Innovations in mining do not make the same headlines as innovations in, say, electronics and cars. That is partly because it does not immediately lead to fancy new consumer products but, more deeply, it reflects a lack of appreciation for the importance of mining innovation. The productivity of extracting minerals from the earth has vastly improved since steam engines were introduced to clear water out of mines more than 200 years ago. The extraction and refinement of minerals now spans many fields of research and technology, from under-sea mining robots to chemical refinement methods. Raw mineral materials are at the root of industrial supply chains and the ability to supply ever-larger quantities of such materials has been a key contributor to the growth of the world economy. What's more, mining innovations have contributed to improved public health, by enhancing the safety of mining workers and limiting their exposure to harmful substances. Mining innovations have also reduced the adverse environmental impact of extraction activities, to which societies have rightly paid increasing attention.

Looking into the future, the importance of mining innovation will be no less important. With growing populations and growing economies, the demand for mineral products is set to increase. New "upstream" technologies generate new demands for certain minerals – such as lithium for battery-powered vehicles. Yet digging minerals from the earth is getting harder. The quality of existing mineral reserves is declining, rendering their extraction more difficult and complex. At the same time, the need to protect the environment and prevent climate change has become an even greater imperative. Technological innovation holds the key to addressing these challenges. There is promising potential in a number of technology fields relevant to mining, ranging from

mechanical engineering to biotechnology. New digital technologies promise to take the automation of mining tasks to a new level.

Opportunities for technological progress are hard to predict. Only time will tell how successful future mining innovations will be in raising mining productivity. There is an important role for governments in shaping the innovation ecosystem in which opportunities for technological progress are realized. Companies operating in the mining sector are at the forefront of innovation. Their incentives to innovate depend on a wide range of policies, including the tax treatment of R&D investments, the protection of intellectual property rights, environmental regulations, and safety standards. In addition, companies draw on knowledge generated by academia and specialized research institutes, many of which are publicly funded.

Charting a government strategy in support of mining innovation requires solid evidence on the effectiveness of different policy approaches as well as their wider pros and cons. Unfortunately, just as mining innovation itself is under-appreciated, there is a dearth of economic research for policymakers to use as an empirical basis for decision-making. It is with this background in mind that IP Australia and WIPO joined forces in 2017 to contribute to a better understanding of the nature and drivers of mining innovation. Patent data offered an obvious entry point to study mining-related technologies, but it soon became clear that a broader approach was needed to study this field of innovation. In addition, other countries expressed interest in pursuing this line of research, leading to a set of studies that eventually gave rise to this edited book volume. Anyone interested in the multifaceted dimensions of mining innovation will find this book worthwhile reading. We hope that policymakers in particular will draw inspiration from the evidence presented in the various chapters to promote policies that contribute to vibrant mining innovation and, ultimately, to a more productive mining sector that supports economic growth as well as broader societal objectives.