

# SEG 2024 Conference: Sustainable Mineral Exploration and Development

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## Innovative Narrow Reef Mining (NRE) Technology for Ultrathin Subhorizontal Ore Deposits

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Traditional underground mining methods, utilizing standard LP equipment (low profile; 2.2 m), when applied to low-grade, thin, subhorizontal orebodies, result in significant dilution of the ore due to the extraction of large amounts of waste rock. To address this issue, ultralow-profile mining equipment (0.9–1.7 m; the NRE fleet) has been developed by Croatian DOK-ING company. The NRE fleet includes the NRE dozer, drill rig, and support rig. Each machine operates within a width range of 0.9 to 1.7 m at a slope of 22° (up to 25° for the dozer), and they are all remote-controlled, fully automatic, equipped with tracked undercarriages, and electrical.

To estimate the market potential of the NRE fleet, basic geological and mineralogical features of over 200 subhorizontal ore deposits/prospects/mineralizations have been analyzed:

1. PGE reef deposits within layered mafic-ultramafic complexes are NRE-suitable. Bushveld complex hosts 25 NRE-suitable PGE underground mines, Great Dyke of Zimbabwe hosts 10 suitable mines. Mafic-ultramafic intrusions at Stillwater, Muskox, and Greenland are NRE-suitable. Other European, Asian, and Australian deposits (Penikat&Portimo, Kemi, Fedorov Tundra, Monchegorsk Complex, Rinco del Tigre) are tectonically highly disturbed or a productive zone is too thick.
2. Witwatersrand gold reef deposits are NRE-suitable (productive zone 0.35 – 3 m, dipping 10–22°)
3. Magmatic Ni-Cu-PGE sulfide deposits within:
  1. Mafic-ultramafic rocks of the Noril'sk–Talnakh intrusion are NRE-suitable. Other Asian massifs (Kluane, North Rock, Uitkomst, Jinchuan, Kola, Ural, Kondyor, Kempirsay, Khabarninsky, Nuralinsky) are not suitable.
  2. Gabbro-norite are generally not suitable (too thick productive zone or steeply dipping deposits). A single NRE-suitable project in Sudbery basin is detected. Analyzed Duluth and Lac des Iles complex are not suitable.
  3. Komatiite are generally not suitable. Only two deposits/projects out of 20 analysed from Australia (Kambalda, Lake Johnston), Europe (Central Lapland, Suomussalmi), and North America (Abitibi, Capa Smith) are suitable.
4. European Cu-kupferschiefer deposits are highly suitable.