

**CHARACTERISTICS OF NICKEL–COBALT (Ni–Co) ENRICHMENT IN
LATERITE NICKEL DEPOSITS OF PAKAL ISLAND, MABA DISTRICT, EAST
HALMAHERA, NORTH MALUKU**

ABSTRACT

The increasing global demand for cobalt, projected to reach 390,000 tons by 2030, has drawn growing attention to the potential of laterite deposits as strategic mineral resources, particularly in ultramafic rock regions such as eastern Indonesia. This study was conducted on Pakal Island, Maba District, East Halmahera, North Maluku. It aims to examine the geological conditions, geochemical characteristics of nickel laterite deposits, and the enrichment of cobalt (Co) in the study area. The methods employed include geological field mapping, rock sampling, and laboratory analyses involving petrography, XRD, XRF, and SEM-EDX. The results show that the Dunit and Harzburgit units contain olivine, orthopyroxene, and serpentine minerals. The limonite zone contains hematite, goethite, and lithiophorite, while the saprolite zone contains garnierite and enstatite. Co enrichment is predominantly found in the limonite layer (0.12–0.15%) and is influenced by lithology, degree of serpentinization, topography, geological structures, and the tropical climate, which accelerates chemical weathering. The vertical distribution of Co shows an inverse correlation with Ni. These findings contribute to the understanding of the formation processes and characteristics of nickel–cobalt laterite deposits in eastern Indonesia and provide a scientific basis for future exploration of cobalt-based strategic mineral resources.

Keywords: Cobalt (Co), Geochemistry, Lateritic nickel, limonite, Mineral exploration, Pakal Island, Serpentinization.

**KARAKTERISTIK PENGAYAAN NIKEL - KOBALT (Ni - Co) PADA
ENDAPAN NIKEL LATERIT PULAU PAKAL, KECAMATAN MABA,
KABUPATEN HALMAHERA TIMUR, PROVINSI MALUKU UTARA**

SARI

Meningkatnya permintaan global terhadap kobalt, yang diproyeksikan mencapai 390 ribu ton pada tahun 2030, mendorong tumbuhnya perhatian terhadap potensi cebakan laterit sebagai sumber daya strategis, terutama di wilayah dengan batuan ultramafik seperti Indonesia timur. Penelitian ini dilakukan di Pulau Pakal, Kecamatan Maba, Kabupaten Halmahera Timur, Provinsi Maluku Utara. Penelitian ini bertujuan untuk mengkaji kondisi geologi serta karakteristik geokimia endapan nikel laterit dan pengayaan unsur kobalt (Co) di daerah tersebut. Metode yang digunakan meliputi pemetaan geologi lapangan, pengambilan sampel batuan, serta analisis laboratorium petrografi, XRD, XRF, dan SEM-EDX. Hasil menunjukkan satuan Dunit dan Harzburgit mengandung mineral olivin, ortopiroksen, dan serpentin. Zona limonit mengandung hematit, goethit, dan lithiophorite, sementara zona saprolit mengandung garnierit dan enstatit. Pengayaan Co dominan pada lapisan limonit (0,12–0,15%) dan dipengaruhi oleh litologi, serpentinisasi, topografi, struktur geologi, dan iklim tropis. Distribusi vertikal Co menunjukkan korelasi terbalik dengan Ni. Temuan ini memberikan kontribusi terhadap pemahaman proses pembentukan dan karakteristik endapan nikel-kobalt laterit di wilayah Indonesia timur, serta menjadi dasar ilmiah bagi kegiatan eksplorasi mineral strategis berbasis kobalt di masa mendatang.

Kata kunci: Eksplorasi mineral, Geokimia, Kobalt (Co), Limonit, Nikel laterit, Pulau Pakal, Serpentinisasi.