REFERENCES

Addesso, R., Gonzalez-Pimentel, J. L., D'Angeli, I. M., Waele, J. D., Saiz-Jimenez, C., Jurado, V., Miller, A. Z., Cubero, B., Vigliotta, G., and Baldantoni, D. (2020). Microbial Community Characterizing Vermiculations from Karst Caves and Its Role in Their Formation. *Microbial Ecology*. 81(4): 884–896.

Afandi, A.A., Basri, H.F., Omoregie, A. I., Mokhter, M. A., Hara, H., and Ouhabi, T. (2024). Immobilization of Cadmium Via Ureolytic Bacteria Isolated from Greywater Waste and Horse Faeces. *Malaysian Journal of Fundamental and Applied Sciences*. 20: 998 - 1016

Aithani, D., and Kushawaha, J. (2023). *Heavy Metals Contamination in Environment*. 15–30.

Al – Thawadi. S. (2011). Ureolytic Bacteria and Calcium Carbonate Formation as a Mechanism of Strength Enhancement of Sand. *Journal of Advanced Science and Engineering Research*. 1; 98 – 114

Alshalif, A. F., Irwan, J. M., Othman, N., and Anneza, L. H. (2016). Isolation of sulphate reduction bacteria (SRB) to improve compress strength and water penetration of bio-concrete. In *MATEC Web of Conferences*. 47.

Araujo, M. V., and Schuh, A. (2022). Adsorption of Heavy Metal Ions Copper, Cadmium and Nickel by Microcystis aeruginosa. *International Journal of Environmental Research and Public Health*. *19*(21): 13867.

Armid, Alrum., Shinjo, Ryuichi., Takwir, Amadhan., Ruslan, Ruslan., and Wijaya, Anugrah, R. (2021). Spatial Distribution and Pollution Assessment of Trace Elements Pb, Cu, Ni, Fe and, As in the Surficial Water of Staring Bay, Indonesia. *J. Braz. Chem. Soc*. 32 (2): 299-310.

Azeiteiro RJN, Coelho PALF, Taborda DMG, et al. (2017). Energy-based evaluation of liquefaction potential under non-uniform cyclic loading. *Soil Dyn Earthq Eng*. 92: 650–66

Balali-Mood, M., Naseri, K., Tahergorabi, Z., Khazdair, M. R., and Sadeghi, M. (2021). Toxic Mechanisms of Five Heavy Metals: Mercury, Lead, Chromium, Cadmium, and Arsenic. *Frontiers in pharmacology*. 12.

Basri, Hazlami. Fikri., Omoregie, Armstrong. Ighodalo., and Mokhter, Mohd. Akmali. (2023). Influence of Enriched Urease Producing Bacteria from Leachate and Restaurant Wastewater on Heavy Metal Removal. *Malaysian Journal of Fundamental and Applied Sciences*. 19 (6)

Bernard, K. (2023). *Identification of Gram-positive Bacteria*. Clinical Microbiology Procedures Handbook Aerobic Bacteriology

Bibi, Shazia., Oualha, Meriam., Ashfaq, M. Yousaf., et al. (2018). Isolation, differentiation and biodiversity of ureolytic bacteria of Qatari soil and their potential in microbially induced calcite precipitation (MICP) for soil stabilization. *Royal Society of Chemistry*. 8: 5854.

Bosak, Tanja. (2011). Calcite Precipitation, *Microbially Induced*. Encyclopedia of Geobiology. Springrer, Netherlands.

Caesar, K.H., Kyle, J.R., Lyons, T.W. et al. (2019). Carbonate formation in salt dome cap rocks by microbial anaerobic oxidation of methane. *Nature Communications*. 10 (808).

Cahyadi, A. (2017). Pengelolaan Kawasan Karst dan Peranannya Dalam Siklus Karbon di Indonesia.

Cappuccino, J. G. and C. T Welsh. (2019). *Microbiology: a Laboratory Manual 12thEd*. Pearson. New York.

Castro-Alonso, M.J., Montanez-Hernandez, L. E., Sanchez-Munoz, M. A., et al. (2019). Microbially Induced Calcium Carbonate Precipitation (MICP) and Its Potential in Bioconcrete: Microbiological and Molecular Concepts. *Frontiers in Materials*. 6: 126

Che Pa, M. N. Hakimi., Muda, Khalida., and Ibrahim, H. Umierah. (2025). Heavy metal immobilisation using ureolytic bacteria via microbial induced carbonates precipitation. *Journal of Physics: Conference Series 3003*. 1742-6596.

Chen, Xueyan. and Achal, Varenyam. (2019). Biostimulation of carbonate precipitation process in soil for copper immobilization. *Journal of Hazardous Materials.* 368: 705 – 713.

Cheng, L., Shahin, M., and Mujah, D. (2017). Influence of key environmental conditions on microbially induced cementation for soil stabilization. *J. Geotech. Geoenviron. Eng.* 143.

Cheng, Liang and Shahnin, Mohamed, A. (2019). Microbially Induced Calcite Precipitation (MICP) for Soil Stabilization. *Ecological Wisdom Inspired Restoration Engineering*.

Cho, Sung, Kook., Kim, Chi, Kyung., Park, Kwang, Jin., et al (2016). Remediation system of groundwater contaminants by pumping and treatment oxidation treatment and reverse osmosis membrane.

Choi, S. G., Chu, J., Brown, Robert, C., Wang, K. J., and Wen, Z. Y. (2017). Sustainable biocement production via microbially induced calcium carbonate precipitation:

Use of limestone and acetic acid derived from pyrolysis of lignocellulosic biomass. *ACS Sustainable Chemistry & Engineering*. 6 (5).

Corona, Teresa. (2016). Spectroscopically Characterized Synthetic Mononuclear Nickel–Oxygen Species. *Chemistry – An European Journal.* 22 (38): 13422-13429.

De La Peña-Lastra, S., Pérez-Alberti, A., Osório Ferreira, T., Huerta-Diaz, M. A., and Otero, X. L. (2022). Global deposition of potentially toxic metals via faecal material in seabird colonies. *Dental Science Reports*. 12(1).

Dejong, Jason. T., Soga, Kenichi., Kavazanjian, E., *et al*. (2013). Biogeochemical processes and geotechnical applications: Progress, opportunities and challenges. *Geotechnique*. 63 (4): 287 – 301.

Doyle, J. and Cooper, J. S. (2023). Physiology, Carbon Dioxide Transport. *StatPearls [Internet]*

Drake, H., Åström, M. E., Heim, C., Broman, C., et al. (2015). Extreme 13C depletion of carbonates formed during oxidation of biogenic methane in fractured granite. *Nature Communications*. 6 (1): 7020.

Dubey, A.A., Ravi, K., Mukherjee, A. *et al.* (2021). Biocementation mediated by native microbes from Brahmaputra riverbank for mitigation of soil erodibility. *Sci Rep*. 11: 15250.

Enyedi, Nora, T., Makk, Judit., Kotai, Laszlo., et al. (2020). Cave bacteria-induced amorphous calcium carbonate formation. *Scientific reports*. 10 (8696)

Fadhly, A., and Hadiyansyah, D. (2020). Studi Morfologi dan Geologi Kawasan Karst dalam Pengembangan Konsep Geopark Daerah Silokek, Kabupaten Sijunjung, Sumatera Barat. *Jurnal Sains dan Teknologi: Jurnal Keilmuan dan Aplikasi Teknologi Industri*. 20(2): 228-237.

Farajnia, Aysan., Shafaat, Ali., Farajnia, Safar., Sartipipiour, Mohsen., and Tirkolaei, Hamed, K. (2022). The efficiency of ureolytic bacteria isolated from historical adobe structures in the production of bio-bricks. *Construction and Building Material*. 317

Fattahi, M. Sayed., Soroush, Abbas., and Huang, Niang. (2020). Biocementation Control of Sand against Wind Erosion. *Journal of Geotechnical and Geoenvironmental Engineering*. 146 (6)

Ge, J., Slotsbo, S., Sorensen, J. G., and Holmstrup, M. (2024). Does copper contamination change thermotaxis of the soil arthropod Folsomia candida (Collembola). *Journal of Thermal Biology*. 124, 103950.

Giachino, A., and Waldron, K. J. (2020). Copper tolerance in bacteria requires the activation of multiple accessory pathways. *Molecular Microbiology*. *114* (3): 377–390.

Gomez, M.G., Graddy, C.M.R., Dejong J.T., Nelson, D.C., and Tsesarsky, M. (2018). Stimulation of native microorganisms for biocementation in samples recovered from field-scale treatment depths. *Journal of Geotechnical and Geoenvironmental Engineering*. 144 (1).

Gowthaman, S., Mitsuyama, S., Nakashima, K., Komatsu, M., and Kawasaki, S. (2019). Biogeotechnical approach for slope soil stabilization using locally isolated bacteria and inexpensive low-grade chemicals: A feasibility study on Hokkaido expressway soil, Japan. *Soils and Foundations*. 59 (2): 484 – 499

Gupta, Panja, K., Ranjan, S., and Kumar, Deepak. (2018). *Recent advances in environmental management*. CRC Press

Hadi, S., Abbas, H., Almajed, A., Binyahya, A., and Al-Salloum Y. (2022). Biocementation by Sporosarcina pasteurii ATCC6453 under simulated conditions in sand columns. *Journal of Materials Research and Technology* 18: 4375–4384.

Hu, H.-W., Wang, J.-T., Li, J., Shi, X., Ma, Y., Chen, D., He, J.-Z., & He, J.-Z. (2017). Long-Term Nickel Contamination Increases the Occurrence of Antibiotic Resistance Genes in Agricultural Soils. *Environmental Science & Technology*, 51(2): 790–800.

Hu, Xuesong., Yu, Caihong., Shi, Jinshuai., He, Banghua., Wang, Xinrong., and Ma, Zizhen. (2024). Biomineralization mechanism and remediation of Cu, Pb and Zn by indigenous ureolytic bacteria *B. intermedia* TSBOI. *Journal of Cleaner Production*.

Huynh, N. N., Huyen, N.P.H., Khoi, N. H. T., and Son, N.K. (2023). Eco-friendly method of biocementation for soil improvement and environmental remediation in the context of Viet Nam: a state-of-the-art review. *Vietnam Journal of Science and Technology*. 61 (6): 917 – 942

Imran, M.A., Kimura, S., Nakashima, K., Evelpidou, N., and Kawasaki, S. (2019). Feasibility Study of Native Ureolytic Bacteria for Biocementation Towards Coastal Erosion Protection by MICP Method. *Applied Science.* 9 (20): 4462.

Irawati, W., Ambarita, P. P., Sihombing, D. l., and Adventia, V. E. S. R. (2022). Isolation and characterization of indigenous copper resistant bacteria from Yogyakarta tannery factory waste. *Jurnal Biologi Tropis.* 22 (3): 795-802

Jiang, N. J., Wang, Y.J., Chu, J., *et al*. (2021). Bio-mediated soil improvement: An introspection into processes, materials, characterization and applications. *Soil Use and Management*. 38: 68 – 93

Jiang, Ning-Jun., Tang, Chao-Sheng., Yin, Li-yang., Xie, Yue-Han., and Shi, Bin. (2019). Applicability of Microbial Calcification Method for Sandy-Slope Surface Erosion Control. *Journal of Materials in Civil Engineering*. 31.

Jones, Daniel. S., and Northup, Diana E. (2021). Cave Decorating with Microbes: Geomicrobiology of Caves. *Elements*. 17 (2): 107-112.

Khalaj, S., Naseri, H., Talebi, M., Ghale, R. A., and Tabandeh, F. (2024) Evaluation of microbial-induced calcite precipitation performance for soil surface improvement and toxicity assessment of the biostabilizer. *Heliyon*. 10 (16).

Kieu, Hoa, T. Q., Muller, Elizabeth., and Horn, Horald. (2011). *Heavy metal removal in anaerobic semi-continuous stirred tank reactors by a consortium of sulfate-reducing bacteria*. Water Research. 45 (13): 3863-3870.

Kim, Gunjo., Kim, Janghwan., and Youn Heejung. (2018). Effect of Temperature, pH, and Reaction duration on Microbially Induced Calcite Precipitation. 8 (8).

Kim, Y. and Roh, Y. (2024). Microbial Precipitation of Calcium Carbonate for Crack Healing and Stabilization of Sandy Soils. *Applied Science*. 14 (4): 1568.

Knittel K, and Boetius A. (2009). Anaerobic oxidation of methane: progress with an unknown process. *Annual Rev Microbiology*. 63:311-34.

Kraamwinkel, C.T., Beaulieu, A., Dias, T., and Howison, R.A. (2021). Planetary limits to soil degradation. *Communications Earth and Environment*. 2: 249

Krajewska, B. (2018). Urease-aided calcium carbonate mineralization for engineering applications: A review. *Journal of Advanced Research* 13: 59–67.

Kumar, A., Kumar, V., Thakur, M., Bakshi, P., Koul, A., Javaid, A., Radziemska, M., & Pandey, V. C. (2023). Comprehensive review of nickel biogeochemistry, bioavailability, and health risks in the environment. *Land Degradation & Development*.

Kumari, S., and Mishra, A. (2021). *Heavy Metal Contamination*. IntechOpen.

Li, L., Fu, Ml., Zhao, Yh, and Zhu, Yt. (2012). Characterization of carbonic anhydrase II from Chlorella vulgaris in bio-CO2 capture. *Environ Sci Pollut Res*.19: 4227–4232.

Li, X., Wang, Y., Tang, J., and Li, K. (2022). Removal Behavior of Heavy Metals from Aqueous Solutions via Microbially Induced Carbonate Precipitation Driven by Acclimatized Sporosarcina pasteurii. *Applied Sciences*. 12(19): 9958.

Liu, B., Zhu, C., Tang, C., Yuehan, X., Liyang, Y., Cheng, Q., and Shi, B. (2020). Bio-remediation of desiccation cracking in clayey soils through microbially induced calcite precipitation (MICP). *Engineering Geology*. 264

Liu, KW., Jiang, NJ., Qin, JD. *et al.* (2021). An experimental study of mitigating coastal sand dune erosion by microbial- and enzymatic-induced carbonate precipitation. *Acta Geotech.* 16: 467–480

Liu, Lie., Lan, Huachun., Cui, Yuqi., et al. (2024). A Janus membrane with electro-induced multi-affinity interfaces for high-efficiency water purification. *Sciences Advances*. 10.

Mahawish, A., Bouazza, A., and Gates, W.P. (2018). Factors affecting the bio-cementing process of coarse sand. *Proc. Inst. Civ. Eng. Improv*. 1–45.

Marlina. (2008). Identifikasi bakteri *Vibrio parahaemolitycus* dengan metode biolog dan deteksi gen ToxR nya secara PCR. *J. Sains Teknologi Farmasi*. 13:11-17.

Moqsud, M. Azzizul., and Gochi, Takuya. (2024). Evaluation of biocementation of slope soil for erosion control with low-cost materials. *Scientific reports 11*.

Mugwar, A. J., and Harbottle, M. J. (2016). Toxicity effects on metal sequestration by microbially-induced carbonate precipitation. *Journal of Hazardous Materials*. 314: 237-248.

Mujah, Donovan., Shahin, Mohamed. A., and Cheng, Liang. (2016). State-of-the-Art Review of Biocementation by Microbially Induced Calcite Precipitation (MICP) for Soil Stabilization. *Geomicrobiology Journal*.

Mwandira, Wilson., Purchase, Diane., Mavroulidou, Maria., Gunn, Michael J. (2023). Synthesis and Utilisation of Hybrid Metal-Carbonic Anhydrase Enzyme Carrier System for Soil Biocementation. *Applied Sciences*. 13 (17): 9494

Noor, A. E., Fatima, R., Aslam, S., Hussain, A., Nisa, Z. un, Khan, M., Mohammed, A. A. A., and Sillanpaa, M. (2023). Health risks assessment and source admeasurement of potentially dangerous heavy metals (Cu, Fe, and Ni) in rapidly growing urban settlement. *Environmental Research*.

Nugroho, A., Sumarno, A., Ngeljaratan, L. N., *et al*. (2019). Self-Healing Concrete Using Bacteria Calcification from Karst Cave Environment. *Jurnal Kimia Terapan Indonesia*. 21 (1): 7 – 13

Nurmiati, N., Periadnadi, P., Alamsyah, F., and Sapalina, F. (2018). Characterization and Potential of Acid Fermentative and Proteolytic Natural Microflora in Several Products of Traditional Dadih from Lembah Gumanti District West Sumatra, Indonesia. *Int.J.Curr.Microbiol.App.Sci*. 7 (3): 3151-3163.

Oktari, A., Supriatin, Y., Kamal, M., and Syafrulla, H. (2017). The Bacterial Endospore Stain on Schaeffer Fulton using Variation of Methylene Blue Solution. *Journal of Physics: Conf. Series*. 812.

Omoregie, A. I., Ouahbi, T., Basri, H. F., Ong, D. E. L., Muda, K., Ojuri, O. O., Flores, D., and Ammami, M. T. (2024). Heavy metal immobilisation with microbial-induced carbonate precipitation: a review. *Geotechnical Research*. 1–96.

Omoregie, A.I., Muda, K., Ojuri, O.O. *et al.* (2022). The global research trend on microbially induced carbonate precipitation during 2001–2021: a bibliometric review. *Environ Sci* Pollut. 29: 89899.

Park, S., Cho, Y. J., Jung, D. Y., et al. (2020). Microbial Diversity in Moonmilk of Baeg-nyong Cave, Korean CZO. *Frontiers in Microbiology*. 11: 613

Pontel, L. B., Checa, S. K., & Soncini, F. C. (2015). Bacterial Copper Resistance and Virulence. *Springer, Cham*.

Porter H, Dhami NK and Mukherjee A. (2018). Sustainable road bases with microbial precipitation. *Proceedings of the Institution of Civil Engineers – Construction Materials*. 171(3): 95–108.

Qiao, S., Zeng, G., Wang, X., Dai, C., Sheng, M., Chen, Q., Xu, F., & Xu, H. (2021). Multiple heavy metals immobilization based on microbially induced carbonate precipitation by ureolytic bacteria and the precipitation patterns exploration. *Chemosphere*. 274: 129661.

Rizwan, M., Usman, K., and Alsafran, M. (2024). Ecological Impacts and Potential Hazards of Nickel on Soil Microbes, Plants, and Human Health. *Chemosphere*, 142028.

Rohmah, E., Astuti, Febria, Fuji., and Tjong, Djong, H. (2021). Isolation, screening and characterization of ureolytic bacteria from Cave Ornament. *Pak J Biol Sci*. 24 (9): 939-943

Roy B, Das T, Bhattacharyya S. (2023), Overview on Old and New Biochemical Test for Bacterial Identification. *J. Surgical Case Reports and Images*: 6(5).

Rozalski, A., et al. (2012). *Proteus* sp. – an apportunistic bacterial pathogen – classification, swarming growth, clinical significant, and virulence factor. *Lodz University Press.* 8.

Saalidong, B. M., Aram, S. A., Otu, S., and Lartey, P. O. (2022). Examining the dynamics of the relationship between water pH and other water quality parameters in ground and surface water systems. *PLoS ONE*. 17(11)

Sager, M. (2019). Nickel – A Trace Element Hardly Considered. *International Journal of Horticulture*. 3 (2): 75–90.

Seifan, M., and Berenjian, A. (2019). Microbially induced calcium carbonate precipitation: a widespread phenomenon in the biological world. *Applied Microbiology and Biotechnology*. 103(12): 4693-4708.

Shepherd, T. A., and Gomez, M. G. (2024). Microbially Induced Calcite Precipitation via Microbial Organic Acid Oxidation. *Geo-Congress*.

Shi, J., Qian, W., Zhong Jin, Z., Zhou, Z., Wang, X., and Yang, X. (2023). Evaluation of soil heavy metals pollution and the phytoremediation potential of copper-nickel mine tailings ponds. *PLOS ONE*. 18(3).

Shougrakpam, S. and Trivedi, A. (2021). Harnessing microbially induced calcite precipitates to use in improving the engineering properties of loose sandy soils. *Sādhanā* 46(1): 41

Shu, S., Yan, B., Ge, B., Li, S., and Meng, H. (2022). Factors Affecting Soybean Crude Urease Extraction and Biocementation via Enzyme-Induced Carbonate Precipitation (EICP) for Soil Improvement. *Energies*. 15 (15): 5566.

Siddhartha, M., Bikas, S. R., and Joydeep, M. (2021). Effect of biologically induced cementation; via; Ureolysis in stabilization of silty soil. *Geomicrobiology Journal*. 39 (1).

Soda, P. R.K., Mogal, A., Chakravarthy, K., *et al*. (2023). Performance assessment of sustainable biocement mortar incorporated with bacteria-encapsulated cement-coated alginate beads. *Construction and Building Material*. 411

Spencer, Christine, Ann., Sass, Henrik., Paassen Leon, van. (2023). Increased Microbially Induced Calcium Carbonate Precipitation (MICP) Efficiency in Multiple Treatment Sand Biocementation Processes by Augmentation of Cementation Medium with Ammonium Chloride. *Geotechnics.*

Stefaniak. K., Wierzbicki, J., Ksit, B., and Szymczak-Gracyk, A. (2023). Biocementation as a Pro-Ecological Method of Stabilizing Construction Subsoil. *Energies*. 16 (6): 2847.

Sun, Yawen., Liu, Kaiwei., Sun, Daosheng., Jiang, Ningjun., Xu, Wan, Ming., and Wang, Aiguo. (2024). Evaluation of urea hydrolysis for MICP technique applied in recycled aggregate: Concentration of urea and bacterial spores. *Construction and Building Materials.*

Svane, S., Sigurdarson, J. J., Finkenwirth, F., Eitinger, T., and Karring, H. (2020). Inhibition of urease activity by different compounds provides insight into the modulation and association of bacterial nickel import and ureolysis. *Scientific Reports*. *10*(1): 8503.

Tirkolaei, H.K., Javadi, N., Krishnan, V., Hamdan, N., Kavazanjian, E. (2020). Crude Urease Extract for Biocementation. *Journal of Materials in Civil Engineering*. 32 (12)

Tripathi, Kaushlendra, Mani., Kumar, Dinesh., and Mishra, Shruti. (2024). Effect of Contamination of Heavy Metals in Soil and Its Mitigation Strategies: A Review. *International Journal of Plant and Soil Science*.

Wang, S.-Y., Fang, L., Dapaah, M. F., Niu, Q., and Cheng, L. (2023). Bio-Remediation of Heavy Metal-Contaminated Soil by Microbial-Induced Carbonate Precipitation (MICP)—A Critical Review. *Sustainability*. 15 (9): 7622.

Wang, Y., Wang, Y., & Konstantinou, C. (2023). Strength Behavior of Temperature-Dependent MICP-Treated Soil. *Journal of Geotechnical and Geoenvironmental Engineering*.

Wang, Yi-Jie., Han, Xiao-Le., Jiang, Ning-Jun., Wang, J., and Feng, J. (2020). The effect of enrichment media on the stimulation of native ureolytic bacteria in calcareous sand. International. *Journal of Environmental Science and Technology*. 17(3):1795-1808.

White, W. B. (2024). *cave*. https://www.britannica.com/science/cave. 4 November 2024

Wurster, C. M., Munksgaard, N. C., Munksgaard, N. C., Zwart, C., and Bird, M. I. (2015). The biogeochemistry of insectivorous cave guano: a case study from insular Southeast Asia. *Biogeochemistry*. 124(1): 163–175.

Zandi, P., Yang, J., Mozdzen, K., and Barabasz-Krasny, B. (2020). *A review of copper speciation and transformation in plant and soil/wetland systems*. 160: 249–293.

Zhou, G., Xu, Y., Wang, Y., et al. (2023). Study on MICP dust suppression technology in open pit coal mine: Preparation and mechanism of microbial dust suppression material. *Journal of environmental management*. 343. 118181.

Zhu, T., and Dittrich, M. (2016). Carbonate precipitation through microbial activities in natural environment, and their potential in biotechnology: a review. *Front. Bioeng. Biotechnol*. 4:4.