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Abrasivity assessment of Triassic limestone and volcaniclastic sandstone in Mae Moh Basin, northern Thailand: a comparison between RAI and CAI

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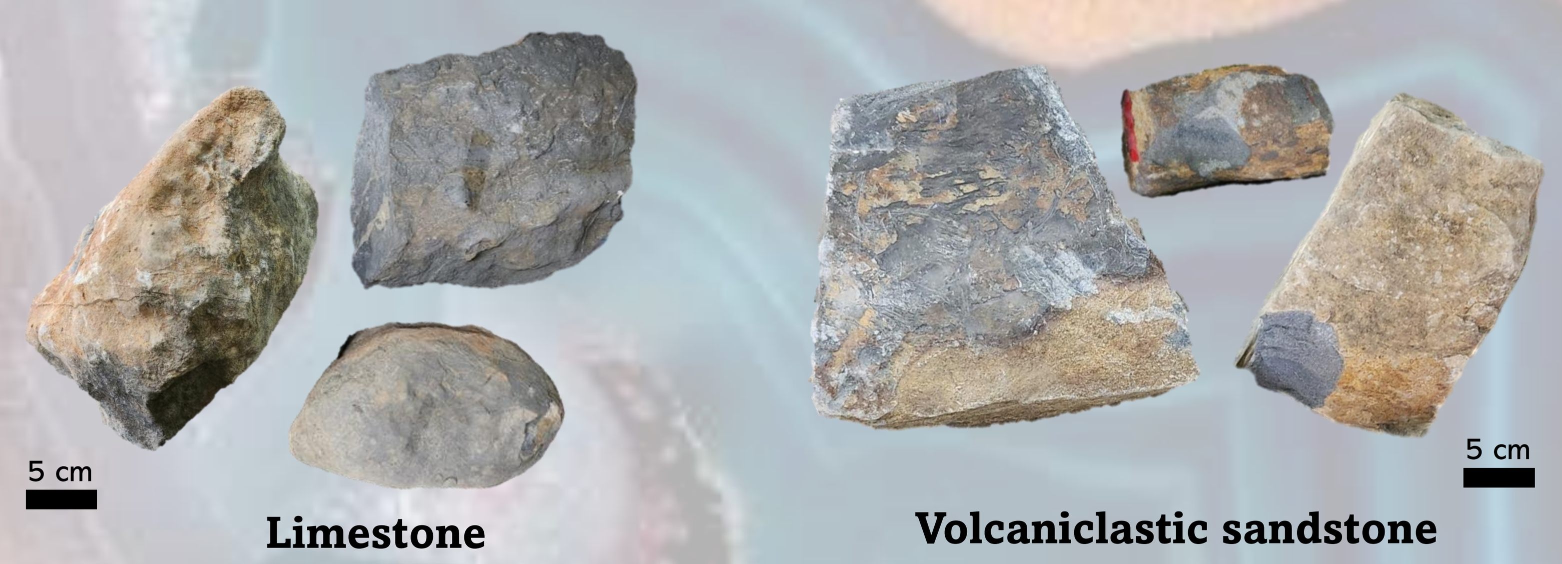
INTRODUCTION & AIM

Rock abrasivity refers to the potential of rock to wear the metal surfaces of tools causing downtime and financial issues in any construction, drilling, or excavation projects. The abrasive degrees of rocks are yielded by mineral composition, mineral hardness, size and shape of grains, type of cement and physical rock properties. This study focuses on two investigation methods to primary evaluate the abrasivity of representative sedimentary rocks observed in the area of Mae Moh District, north of Thailand. Firstly, Rock Abrasivity Index (RAI) is obtained from microscopic modal mineral approach and rock strength test. This abrasivity value is compared to CERCHAR Abrasivity Index (CAI). The CAI involves the use of simplified tools to battle the rock sample surfaces and the measurement of tool wears.

METHOD

a.



b.

$$EQC = \sum_{i=1}^{n}(A_i \cdot R_i)$$

Where, EQC = Equivalent Quartz Content [%]
A_i = a mineral content [%]
R_i = Rosiwal grinding value [%]
n = total of minerals in sample

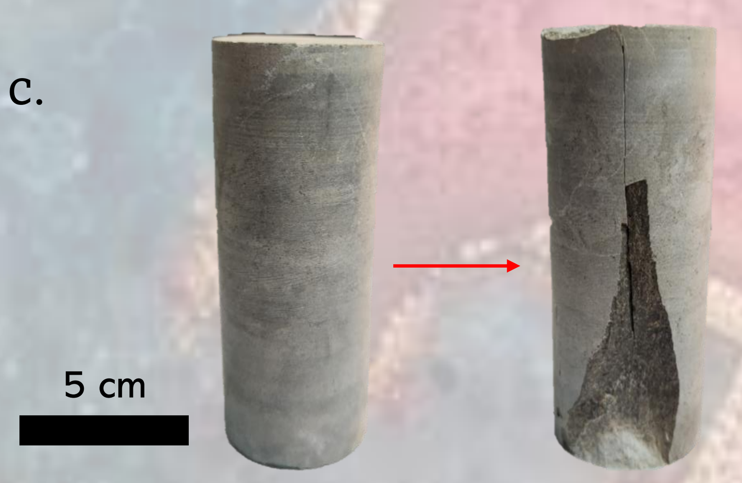
$$\sigma_{UCS} = P/A$$

Where, σ_{UCS} = a rock strength [MPa]
P = the peak axial loads [kN]
A = surface area [mm^2]

$$RAI = EQC \cdot \sigma_{UCS}$$

Where, RAI = Rock Abrasivity Index

c.



d.

$$CAI = d \cdot 10 \cdot 1.143$$

Where, CAI = CERCHAR Abrasivity Index
d = diameter of wear steel stylus [mm]

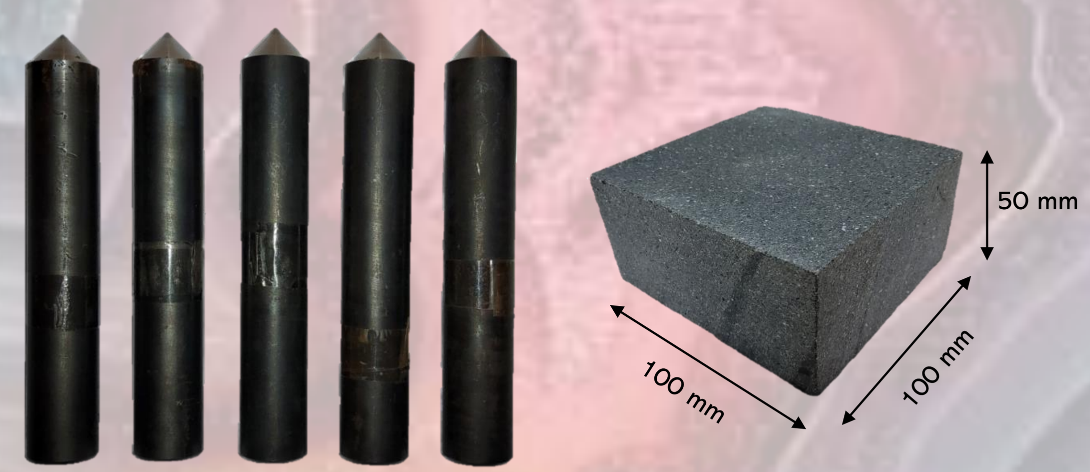


Figure 1. Experiment schemes for rock abrasivity assessment and related equations: (a.) Rock specimens, (b.) Petrographic analysis, (c.) Uniaxial compressive strength testing, (d.) CERCHAR GMR-SUT Model, steel styli and block sample.

REFERENCES

1. ASTM. *Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens;* D2938-95; West Conshohocken, 2017. DOI: 10.1520/D2938-95.
2. ASTM. *Standard Test Method for Laboratory Determination of Abrasiveness of Rock Using the CERCHAR Abrasiveness Index Method;* D7625-22; West Conshohocken, 2022. DOI: 10.1520/d7625-22.
3. Plinninger, R. J. Hardrock abrasivity investigation using the Rock Abrasivity Index (RAI). In *International Association for Engineering Geology and the Environment,* Auckland, New Zealand, 2010; Williams, A. L. Eds.; CRC Press.
4. Thuro, K. Drillability prediction: geological influences in hard rock drill and blast tunnelling. *Geologische Rundschau* ***1997,*** *86 (2).* DOI: 10.1007/s005310050151.

RESULTS AND DISCUSSION

Overall Experimental Results showing the values of RAI and CAI

Experiments	Limestone	Volcaniclastic
EQC [%]	2.53	43.26
σ_{UCS} [MPa]	77.22	92.07
RAI	1.95	39.82
CAI	1.24	2.73
Classification	Not abrasive (RAI) Low abrasive (CAI)	Medium abrasive (RAI) High abrasive (CAI)

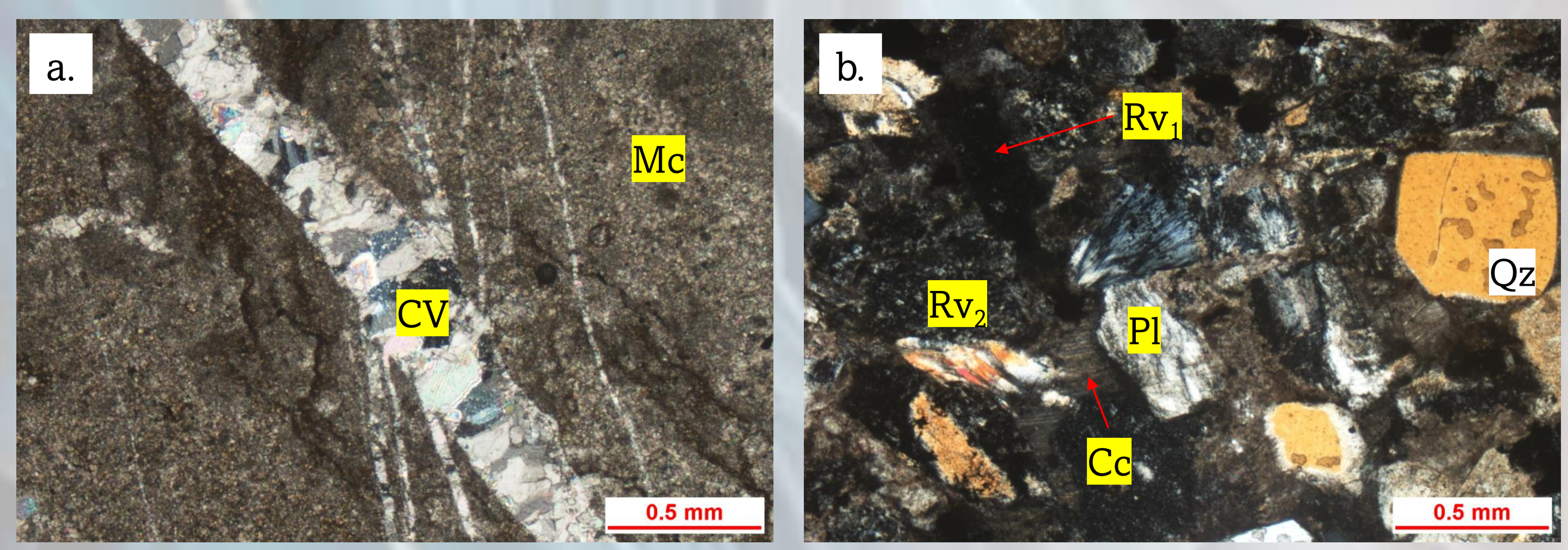
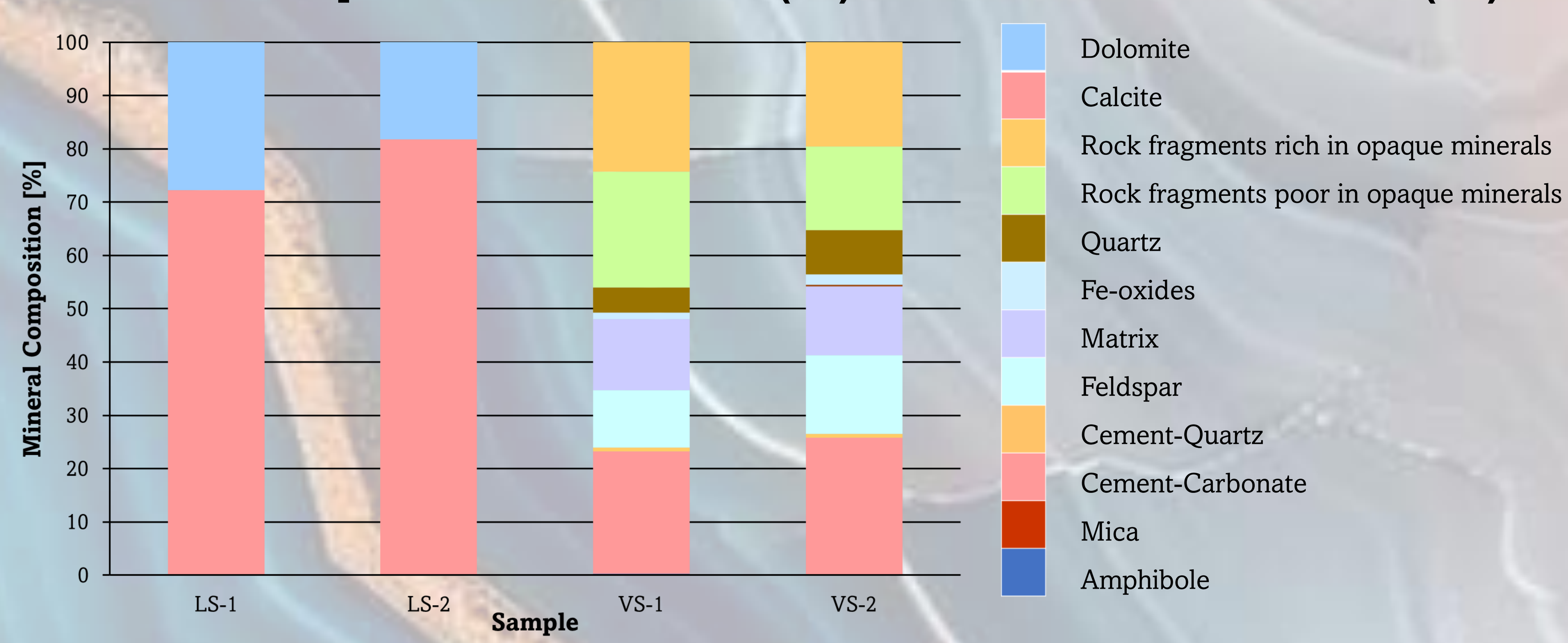


Figure 2. Photomicrographs taken under crossed-polarized light: (a.) Limestone exhibits particles of micrite (Mc) crosscut by calcite veins (CV). (b.) Volcaniclastic sandstone cemented by calcite (Cc) exhibits volcanic rock fragments (Rv) associated with quartz (Qz) and plagioclase (Pl) grains.

Mineral Compositions of Limestone (LS) and Volcaniclastic sandstone (VS)



Mineral assemblages of limestone are predominantly carbonates (calcite & dolomite), whereas those of volcaniclastic sandstone are hard rock fragments and abrasive minerals (quartz & Fe-oxides)

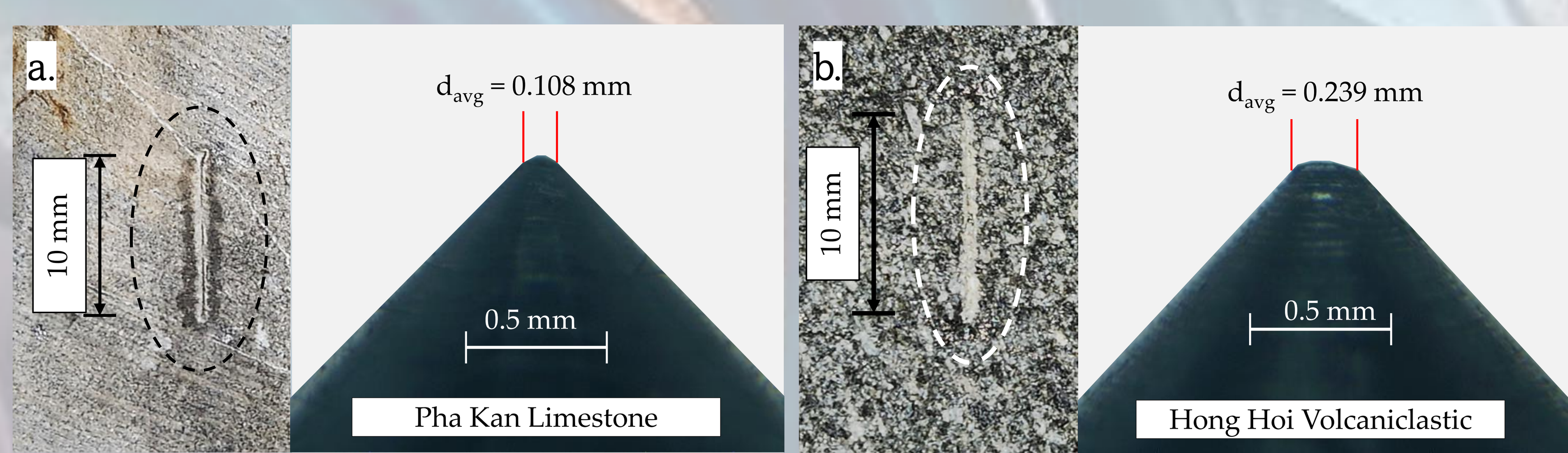


Figure 3. Photomicrographs of worn styli from scratching on rock sample surfaces with their average worn diameter: (a.) Limestone, (b.) Volcaniclastic sandstone.

The stylus scratched on the volcaniclastic sandstone shows wider wear diameter than the one scratched on the limestone

The different interpretations of RAI and CAI possibly induced by their investigation scale approaches. The RAI uses the effects of mineralogical and mechanical properties of rocks, focusing on the micro-scale, and serves as a strategy for assessing rock abrasiveness. In contrast, the CAI employs a larger-scale physical approach than the RAI method. This study focuses on two investigation methods to evaluate the abrasivity of representative sedimentary rocks. Firstly, Rock Abrasivity Index (RAI) is obtained from microscopic modal mineral approach and rock strength test. This abrasivity value is compared to CERCHAR Abrasivity Index (CAI). The CAI involves the use of simplified tools to battle the rock sample surfaces and the measurement of tool wears. We believed that the CAI could provide more realistic model of the tool wear caused by rock samples.

CONCLUSION

Rocks containing high abrasive mineral contents exhibit greater abrasivity than those containing soft minerals. The rock abrasivity of the studied samples interpreted from the CAI values appears to be slightly higher than those interpreted from the RAI.