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Et av de mest vanlige stoffene i jordskorpen er kalsiumkarbonat. Dette mineralet virker ofte som en naturlig sement for å danne bergarter som kalkstein, kritt og marmor. Til tross for at det er rikelig og viktig i mange industrielle områder, er styrkingsmekanismene i dette naturlige sementbaserte systemet ikke fullt ut forstått ennå. Det å forstå den mekaniske oppførselen til disse naturlig sementerte bergartene er også av relevant betydning, ikke bare fordi de har tradisjonelt blitt brukt som byggematerialer (spesielt i monumenter i Europa), men også fordi mange av verdens største oljereservoarer er funnet i karbonatbergarter. Under disse forholdene er karbonatbergarter utsatt for deformasjon, siden de må tåle belastning i lange perioder, men deformasjonsmekanismene er ennå ikke godt forstått. Viktigheten av kalsiumkarbonatsementsystemet er ikke begrenset til byggematerialer og oljeindustrien, siden den høye biokompatibiliteten gjør det til et perfekt biomateriale for å erstatte eller reparere knokler. I sin avhandling har Jesus Rodriguez Sanchez syntetisert kunstig kalsiumkarbonatsement som et modellsystem for å undersøke disse tre hullene.

One of the most abundant materials found in the Earth's crust is calcium carbonate. This mineral often acts as a natural cement to form rocks like limestone, chalk and marble. However, despite of its abundance and importance in many industrial fields, the strengthening mechanisms of this natural cementitious system are not fully understood yet. In his thesis, Jesus Rodriguez Sanchez has synthesized artificial calcium carbonate cements as a model system to investigate the mechanisms that this cement type follows to gain strength. After mixing the solid reagents with water, he and his supervisors found that the evolution of the elastic properties of the pastes is directly correlated with the particle phase transformations which occur during setting. They suggested that the newly formed calcite particles may attach to each other progressively while the extent of this process may in turn determine the strength of "bridges" between particles, and consequently of the cemented material itself. However, further efforts are still necessary to confirm their hypothesis.

Jesus and his supervisors also made an important breakthrough since they found that calcium carbonate phase transformations within a cement paste system differ from traditional crystallization results. While for stirred solutions the transformation from vaterite into calcite phase is regulated by the available surface of the precipitated calcite particles, within a cement paste this recrystallization is controlled by the dissolution rate of vaterite. This finding may have a significant impact on the way transport in porous materials and cements is studied.

Understanding the mechanical behaviour of naturally formed calcium carbonate cemented rocks is also of relevant importance, not only because those have been traditionally used as construction materials (especially for monuments in Europe) but also because many of the world's largest oil reservoirs are hosted by carbonate rocks. Under these conditions, carbonate rocks are prone to deformation, since they have to withstand loads for long periods of time, but their deformation mechanisms are not well understood yet. Jesus and his supervisors used the calcium carbonate cement system as a model to shed some light on the deformation mechanisms of carbonate rocks. More specifically, they used a novel microindentation approach to study creep deformation and suggested that macroscopic creep of cement samples can be due to a mass transfer that occurs at the microscopic level. This phenomenon is explained by the so-called "pressure solution theory" and is compatible with the proposed "bridging" strengthening mechanism.

Moreover, the importance of the calcium carbonate cement system is not limited to the construction and the oil industries since its high degree of biocompability makes it a perfect biomaterial to substitute or repair bones. To further evaluate this potential application, Jesus and his supervisors studied the bioactive properties of calcium carbonate cement specimens through the formation of bone-like particles over their surface when immersed in simulated body fluid. Their results are encouraging and envisage a great potential for calcium carbonate cement on biomedical applications.