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Compaction history, burial depth and tectonics derived from stylolites in the Oman mountains

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Stylolites are rough seams that develop during localized dissolution of rocks that are under burial or tectonic stresses. Recent work on these structures has shown that they can not only be used to estimate the direction of the main compressive stress but also the amount of compaction and even the absolute value of differential, mean and principal stresses. We use these new methods in the Permian to Mesozoic carbonate rocks of the Oman mountains in order to test the method and to study the burial and tectonic history that led to the development of stylolites. The Oman mountains are of special interest because we can sample stylolites across a 2km thick sequence of rocks, we find bedding parallel and tectonic stylolites and we know that the rocks were buried under the overthrusted Oman ophiolite. The bedding parallel stylolites should contain a signature of the up to 4km thick ophiolite nappe that was on top of the sedimentary rock pile assuming that the increase in overburden stress activated stylolites. Our results show that we can detect the ophiolite nappe, the bedding parallel stylolites in the topmost sediments of the Oman mountains that are situated directly below the ophiolite nappe show a burial depth of at least 2000m. Stylolites in the lowest parts of the rock pile, in the Permian carbonates close to the unconformity with the basement show a depth of at least 3500m. We can estimate that in some parts of the sequence 30 to 40% of the rock mass was dissolved at stylolites and is probably partly precipitated in the abundant vein networks nearby. Stylolites and vein systems seem to be activated at the same time, since bedding parallel and tectonic stylolites dissolve associated veins but are cut by the same veins again. Therefore we think that the Oman mountains are characterized by a sequence of events that led to local mass transfer from dissolution at stylolites to precipitation in veins. Tectonic stylolites show two major horizontal shortening events with the main compressive stress striking ENE-WSW and NE-SW. These directions are consistent with vein stets and faults that are associated with major strike slip events in the area.