MICAS IN CROSS-BEDDED SANDSTONES AND THEIR ABRASIONAL TRENDS

Calvin J. Anderson (calvinanderson1@cedarville.edu), Alexander Struble, John H. Whitmore, Matthew S. Cheney; Department of Science and Mathematics, Cedarville University, 251 N. Main St, Cedarville, OH 45314

ABSTRACT

We have noted micas (mostly muscovite) in several classic cross-bedded eolian sandstones. We have searched for micas in modern eolian settings, but have only found them near crystalline igneous sources. We set out to test the survival of muscovite flakes in the conditions known to produce cross-bedding in sandstones. Our goal was to experimentally test the survival of mica in both eolian and subaqueous environments.

Simulated eolian experiments were carried out in a 4 liter pickle jar with a remote control airplane propeller attached through the lid. Air circulation velocity was controlled so that a small dune continually migrated around the base of the container. Sand samples were mixed at constant speed, over the course of 20 days, and were made into thin sections. Results showed that micas delaminated quickly in such conditions, while a matter of a few days. Very few pieces of visible mica could be found after 6 hours of agitation (about 452 km of travel), even when extracted in muscovite thin sections in this time, most of the mica had degraded into silt- and clay-sized particles.

Simulated subaqueous experiments were carried out in a 1.5 liter pickle jar. This jar was rotated by a rock tumbler at constant speed, so that the sand continually climbed the rising side of the jar, continually migrating around the bottom of the container. In this time, most of the mica had degraded into silt- and clay-sized particles.

Micas were abundant and large in thin section. The only observations of these pieces were in thin section. The mica flakes were still visible. However, the muscovite pieces were significantly more difficult to find, and with only a few exceptions, all loose micas were between 50 and 150 microns.

The same mica-rich Carolina Sand Hills sand was used for both experiments and fines were removed by decantation.

METHODS

Eolian environment was simulated in a special wind chamber designed to produce a 3D saltating dune on the rotational upslope. The particle circulation paths are represented in the drawing below. Note that the wind direction is consistent. The sandline is consistent. The particle distribution is consistent. The wind direction is consistent. The sandline is consistent.

Eolian environment was simulated in a special wind chamber designed to produce a 3D saltating dune on the rotational upslope. The particle circulation paths are represented in the drawing below. Note that the wind direction is consistent. The sandline is consistent. The particle distribution is consistent. The wind direction is consistent. The sandline is consistent.

Subaqueous environment was carried out in a similar wind chamber designed to produce a 3D saltating dune on the rotational upslope. A constant wind speed of 4.78 kph maintained a dune which migrated by saltation. The particle circulation paths are represented in the drawing below. Note that the wind direction is consistent. The sandline is consistent. The particle distribution is consistent. The wind direction is consistent. The sandline is consistent.

No loose micas could be found in this section. The only observed muscovite were small pieces found in the thin section slices through a mica. These observations showed the muscovite flakes were still visible. However, the muscovite pieces were significantly more difficult to find, and with only a few exceptions, all loose micas were between 50 and 150 microns. The subaqueous samples could be easily distinguished from the eolian samples at comparable distances. It is important to emphasize that loose micas remain significant exceptions. Most micas in the thin section were about 200 µm in maximum diameter.

ACKNOWLEDGEMENTS

Significance of these findings

Our experiments in eolian settings show micas become significantly reduced both in size and abundance with short transport distance. Our experiments in subaqueous settings show micas can remain large and abundant over long transport distances. Therefore, sandstones that contain significant amounts of micas are likely to have been transported in subaqueous environments based on this study.

DISCUSSION

Gebrel et al. (2011) showed that the aragonite found in Peruvian soils of Coorong Gorge have P-84 signatures which closely match those of the Appalachian. They concluded that these signatures are consistent with being transported from the Appalachian region. In this interpretation the fluuvialite would be isolated at the base of the other grains. They suggested the necessary transport in excess of 3000 km could be accomplished by oxic conditions following burial, possibly by microbial biodegradation and reworking.

However, our results demonstrate that micas (such as those shown below) could not have resided for more than 50 km by eolian processes. Even this estimate is quite generous, considering that a single mica grain would need to have more than 4500 km of exposure to dissolve. While there is uncertainty about the exposure of such grains, the effect is seen in the extreme concentration of micas in the Coconino and in several other classic eolian sandstones. It is important to note that the micas seen here are situated among the grain rather than within individual grains.