The Eagle Ford consists almost entirely of interbedded marl and limestone. The permeability of tight rocks measured on crushed core material cannot take into account this laminated textures of the marls, which is destroyed in the crushing process. Rosen et al. (2014) described a dual-pump system that can measure permeabilities below 1 nD using low viscosity, low compressibility supercritical CO\textsubscript{2}, which is miscible with residual core liquids. This dual-pump system utilizes an injection pump operating at constant rate with a back pump maintaining constant pressure. This system was used to measure permeability on 36 plugs from the Eagle Ford representing a range of textures, compositions and facies. The TOC (total organic carbon) content of these samples varied between 2 and 12%, the porosity ranged from 8 to 12% and the thermal maturity ranged from a vitrinite reflectance (Ro) of 0.62 to 1.45.

The permeability of the marls in the Eagle Ford was found to be on the order of 1 to 10 nD, with permeability increasing with increasing calcite content. Permeability increased with the degree of lamination, with finely laminated marls being more permeable than marls without any lamination. The limestones were found to be more permeable than the marls, likely due to the presence of microfractures, which were likely closed in the subsurface and reopened by the coring process, but suggest that when stimulated, would have higher permeability in the subsurface than the non-laminated marls.

Scanning electron microscope (SEM) microscopy on ion-milled surfaces of the permeability plugs and a low thermal maturity outcrop sample (Ro = 0.4–0.55) was used to characterize the pore system of the Eagle Ford and determine its control on matrix permeability. All of the intergranular pores of the samples studied, regardless of TOC, mineralogy, or facies, contained hydrocarbons.

The lowest maturity samples contained viscous hydrocarbon that lined larger pores and filled smaller ones. The samples with thermal maturities inside the oil window were filled with solid hydrocarbon that contained slit-shaped pores, whereas the more thermally mature samples were filled with solid hydrocarbon. The thermally mature samples contained both porous and non-porous solid hydrocarbon, the latter largely being present inside foraminifera tests.

The highest TOC samples were marls that contained hydrocarbon throughout the intergranular pores of the matrix. The TOC was lowest in the limestones, with the hydrocarbon filling the matrix within the few intergranular pore spaces present. In one limestone sample, solid hydrocarbon lined open microfractures.

Visual kerogen analysis (VKA) and solvent extraction on the thermally mature samples determined the non-porous solid hydrocarbon to be bitumen and the non-porous solid hydrocarbon to be pyrobitumen. The solid hydrocarbon in the thermally mature plugs is of varying thermal maturities, indicating that the hydrocarbons within the Eagle Ford have migrated within the rock, effectively occluding primary pores like a diagenetic cement. This organic-matter cement is porous, but permeability was not found to be directly related to thermal maturity or the total organic carbon content, but rather to the texture of the rock.