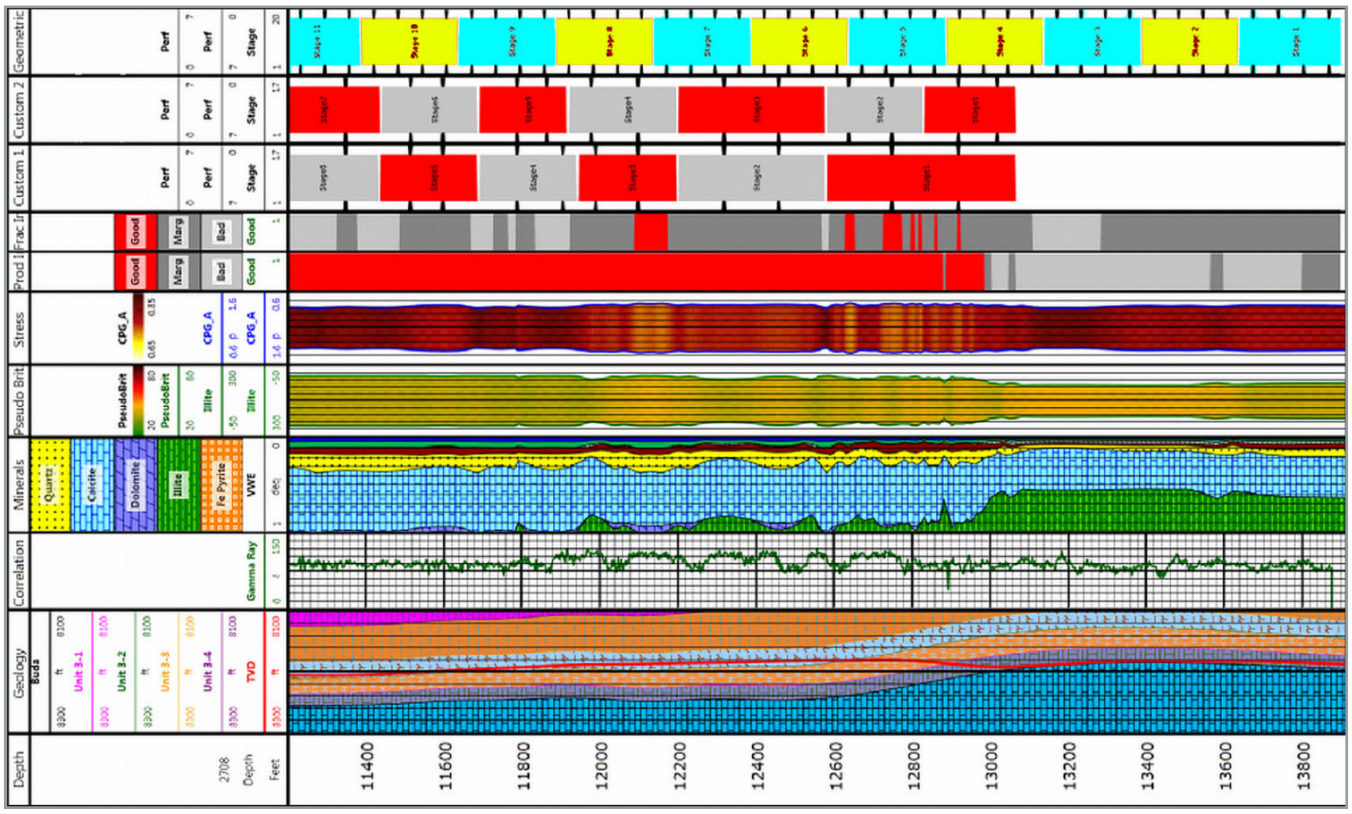
FracInsight℠ Service - "Where to Frac"



Custom Staging - Eagle Ford Shale

The Halliburton FracInsight℠ service is an unbiased, repeatable interpretation workflow that leverages the best available horizontal well data to select perforation clusters and frac stage locations. It is designed to create a more consistent fracturing operation by eliminating the fracturing of nonproductive rock, reducing inconsistent breakdown and treating pressures, and minimizing screenout or "go-to-flush" early instances.

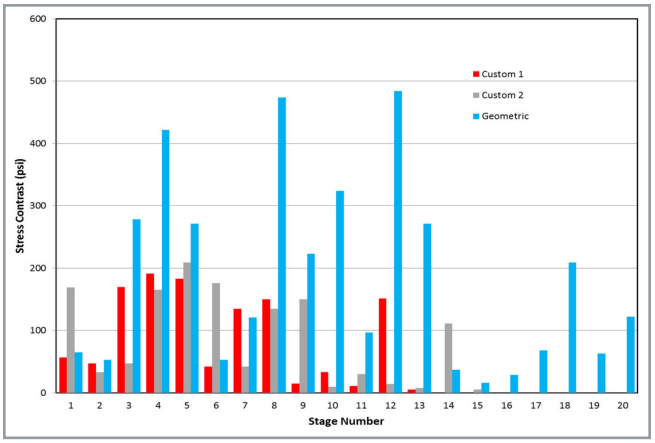
The FracInsight℠ service provides a "Production Index" and "Frac Index" that are combined to optimize stage and cluster placement. The Production Index uses individually weighted criteria such as facies quality, effective porosity, and brittleness to quantify the differences in reservoir character. The Frac Index uses weighted criteria such as closure stress, natural fracture index, and cement bond index to highlight areas of differing mechanical properties or mechanical risk.

Two different custom frac staging designs are generated based on the client's preferred input criteria. These two designs are compared with a conventional geometric spaced design or an external design supplied by the client in order to analyze net stress and treating pressure differences between clusters in individual stages. One of the custom designs is also typically optimized for the absolute best rock and least pressure differential between clusters.

This solution offering is designed to support all levels of available horizontal well formation evaluation. It has long been recognized that while LWD gamma ray steering in source rock reservoirs may be cost-effective, it actually offers little to no reliable information regarding the actual rock properties the well path is intersecting. The geosteering professional may or may not be within the ideal target window, depending on lateral variability, localized formation dip changes, and microfaulting of the reservoir itself.

Halliburton Custom Design 2 Report									
Stage Number	Stage Top (ft)	Stage Bottom (ft)	Perforation Top (ft)	Perforation Bottom (ft)	Mid Perf TVD (ft)	Perforation Spacing (ft)	Closure Pressure Gradient (psi/ft)	Closure Pressure (psi)	Stress Contrast (psi)
15	8889	9266	8998	9000	8263	148	0.758	6265	5
			9148	9150	8265	228	0.757	6260	
14	9274	9496	9378	9380	8257	78	0.762	6289	111
			9458	9460	8251	88	0.749	6178	
13	9604	9725	9548	9550	8245	78	0.741	6110	8
			9628	9630	8242	178	0.740	6102	
12	9733	9966	9808	9810	8241	78	0.740	6096	14
			9888	9890	8240	148	0.742	6110	
11	9974	10196	10038	10040	8237	78	0.743	6121	30
			10118	10120	8236	128	0.740	6091	
10	10204	10436	10248	10250	8233	78	0.745	6130	10
			10328	10330	8232	306	0.744	6120	
9	10444	10846	10638	10640	8226	134	0.744	6122	150
			10774	10776	8222	122	0.763	6272	
8	10854	11116	10898	10900	8216	108	0.736	6049	135
			11008	11010	8212	188	0.753	6184	
7	11124	11436	11198	11200	8206	148	0.803	6591	42
			11348	11350	8205	165	0.798	6549	
6	11444	11686	11515	11517	8202	81	0.787	6459	176
			11598	11600	8198	188	0.766	6282	
5	11694	11915	11788	11790	8193	74	0.763	6417	209
			11864	11866	8191	112	0.809	6626	
4	11923	12196	11978	11980	8188	118	0.762	6241	165
			12098	12100	8187	218	0.742	6076	
3	12204	12576	12318	12320	8185	138	0.763	6241	47
			12458	12460	8182	178	0.757	6194	
2	12584	12826	12638	12640	8182	108	0.738	6035	33
			12748	12750	8181	168	0.742	6069	
1	12834	13064	12918	12920	8188	98	0.748	6125	169
			13018	13020	8192	-	0.768	6294	

Custom Design Report



Maximum Stress Differential per Frac Stage

Without any other information than an LWD gamma ray, the workflow can make use of Sperry Drilling's StrataSteer® 3D software by performing a post-drill stratigraphic correlation. This is done by projecting formation properties derived from a ShaleXpert℠ interpretation from the closest offset well along the horizontal wellbore. While this scenario ignores the concept of laterally changing rock properties, it offers the best chance to model reasonable rock properties based on actual wellbore placement with zero risk and minimal expense. This simplest version of the workflow should be applied only when the local stratigraphic structure is well defined. This application is ideal for subsequent development wells in a pad drilling application.

Ideally, the actual interpretation should be performed using LWD or horizontal openhole wireline logs. However, these solutions are expensive and add risk within a development drilling program. A no-risk solution exists with the use of the Advanced Sample Analysis℠ service from drill cuttings to identify changing total organic carbon (TOC), mineralogy, and stress regimes along the well. A low-risk cased-hole FracCombo service, consisting of the pulsed-neutron Reservoir Monitoring (RMT™i) and UltraSlim℠ Borehole Sonic Array Tool services, can be pumped down or tractor conveyed after casing is set to identify the same properties along with effective porosity and a bond log. Both of these services are viable cost-effective options to provide quality staging inputs for the FracInsight℠ service.

If absolute precision in measuring differential anisotropic stress is required for a critical horizontal well, an openhole LWD XBAT™ Azimuthal Sonic tool can be run as a last wiper trip. This method also requires some form of bulk density measurement, which can be obtained using the through-casing FracCombo℠ service after the rig has moved. This solution also helps minimize risks by leveraging openhole and cased-hole operations.

For more information, contact your Halliburton representative.

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