

Compilation and Discussion of In-situ Stress Measurements in Southern Saskatchewan

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Summary

This presentation will summarize the results of efforts to compile new in-situ stress data for the 2027 edition of the Geological Atlas of the Western Canada Sedimentary Basin. The new data consist mainly of minimum horizontal stress magnitudes (and gradients) given in diagnostic fracture injection test reports, and horizontal stress orientations interpreted from borehole image logs in southern Saskatchewan. The new dataset represents a significant increase in the number of data points for the province compared to the 1994 Atlas, and includes data from a broader array of industrial activities such as carbon storage, geothermal energy development, brine disposal and helium exploration. A composite dataset consisting of the new data and from the 1994 Atlas will be presented and discussed within the context of the tectonic setting of southern Saskatchewan. A summary of results obtained to date is given below.

Results

Table 1 presents a summary of stress magnitude data from the 1994 Atlas (Belle et al., 1994) and new data compiled to date for the 2027 Atlas Project. Figure 2 shows the locations of wells referenced in Table 1. Minimum horizontal stress gradients from Table 1 are plotted against depth in Figure 2. These results suggest that minimum horizontal stress gradients in southeast Saskatchewan and southwest Manitoba are generally lower than those reported for the central and western portion of Saskatchewan.

Figure 3 presents horizontal stress orientation data from the 1994 Atlas and new data points compiled to date for the 2027 Atlas Project. The new data are located near the southern border of Saskatchewan, and were measured in Cambro-Ordovician and Precambrian-age rocks. The NW-SE orientations of these new data points are consistent with many of the orientations previously reported for Mesozoic and Paleozoic-age rocks in southern Saskatchewan.

References

Bell, J.S., Price, P.R. and McLellan, P.J., "In-situ Stress in the Western Canada Sedimentary Basin", Chapter 29 in the Geological Atlas of the Western Canada Sedimentary Basin, Published jointly by the Canadian Society of Petroleum Geologists and the Alberta Research Council, Calgary, 1994, pp. 439-446.

Table 1: In-situ stress magnitude data for southern Saskatchewan and southwest Manitoba.

Map Ref. No.	UWI	Test Type	Depth (mKB)	σ_{Hmin} (MPa)	σ_v (MPa)	σ_{Hmax} (MPa)	σ_{Hmin}/z (kPa/m)	Formation (Age)
<u>From 1994 Atlas</u>								
1	100/06-04-002-29W1/00	Minifrac	1029	15.4			15.0	Duperow Fm (Devonian)
2	100/14-13-009-28W1/00	Minifrac	728	12.6			17.3	Mannville Gp (Cretaceous)
3	101/05-15-006-10W2/00	Minifrac	1394	16.5			11.8	Midale Beds (Mississippian)
4	101/11-20-006-10W2/00	Minifrac	1388	17.0			12.2	Midale Beds (Mississippian)
5	191/09-23-006-11W2/00	Microfrac	1432	17.1-22.6			c. 13.1	Midale Beds? (Mississippian)
6	131/03-08-017-19W2/00	Microfrac	2065	35.7	51.6	40.7	17.3	Winnipeg Fm Sandstone (Ordovician)
			2168	40.1	54.2	55.3	18.5	Deadwood Fm (Cambrian)
			2213	41.1	55.3	52.8	18.6	(Precambrian)
<u>From 2027 Atlas Project</u>								
7	101/10-28-028-24W3/00	Microfrac	680	14.7			21.6	BFC (Cretaceous)
			705	9.4			13.3	Viking Fm (Cretaceous)
			729	16.0			21.9	Joli Fou Fm (Cretaceous)
8	101/06-36-045-16W3/00	Microfrac	1152	23.9	26.4		20.8	U. Deadwood shale (Cambrian)
			1215	23.4	27.8		19.3	L. Deadwood shale (Cambrian)
			1384	26.3	31.8		19	Earlie shale (Cambrian)
			1465	30.1	33.7		20.5	Basal Sand Unit (Cambrian)
			1483	33.8	34.1		22.8	Basal Sand Unit (Cambrian)
9	141/01-09-001-04W2/00	DFIT	2198	33.5			15.2	Duperow Fm (Devonian)
10	131/16-30-022-17W3/00	Minifrac	330	6.75	6.97		20.45	Milk River (Cretaceous)
11	101/05-06-002-08W2/00	Microfrac	3142	49.2			15.6	Winnipeg Fm Ice Box Shale (Ordovician)
12	101/08-06-006-13W2/00	Minifrac	1355	22.2			16.4	L. Watrous (Trassic)

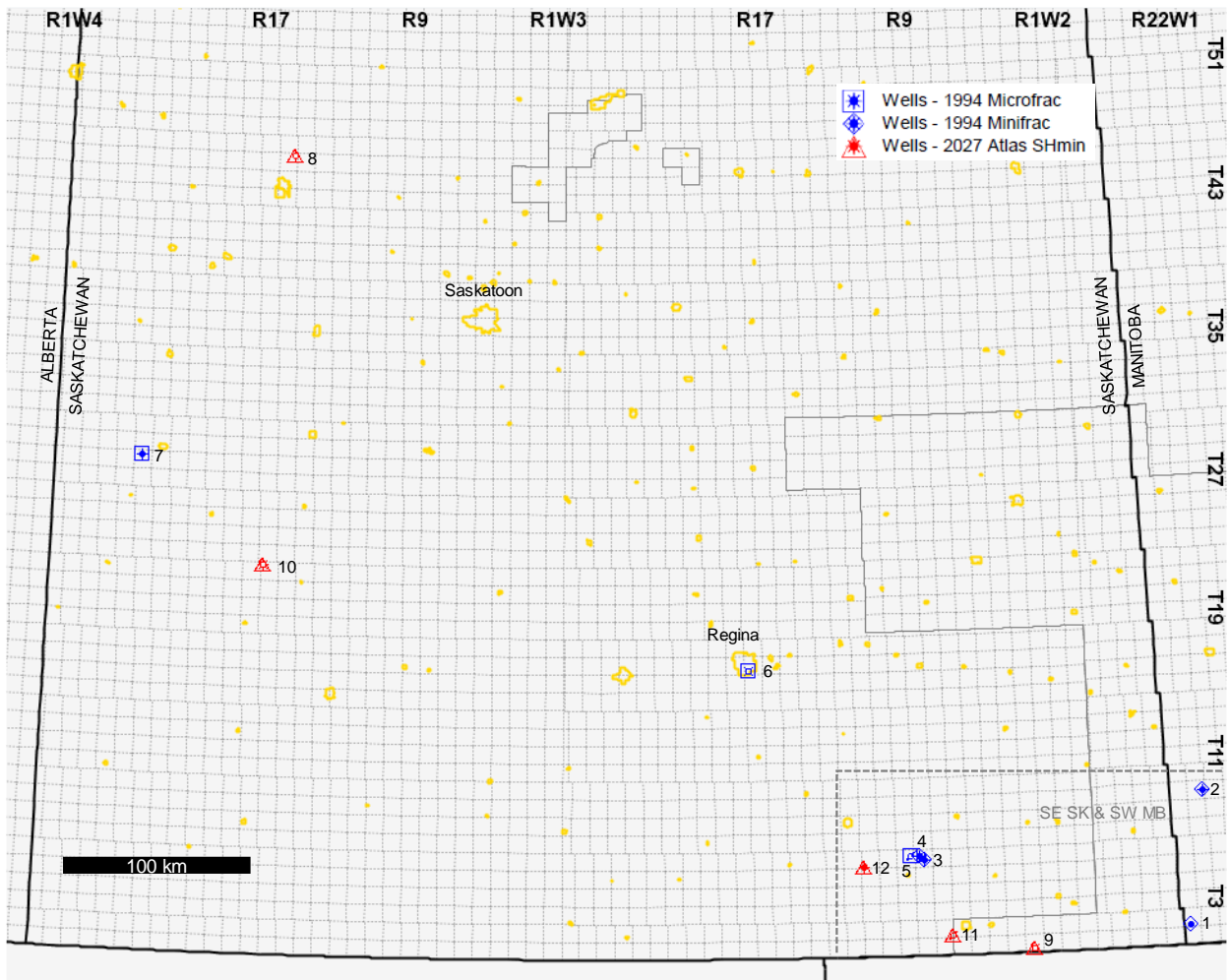


Figure 1: Location of in-situ stress magnitude measurements in southern Saskatchewan and southwest Manitoba. The number beside each well is the reference number reported in Table 1.

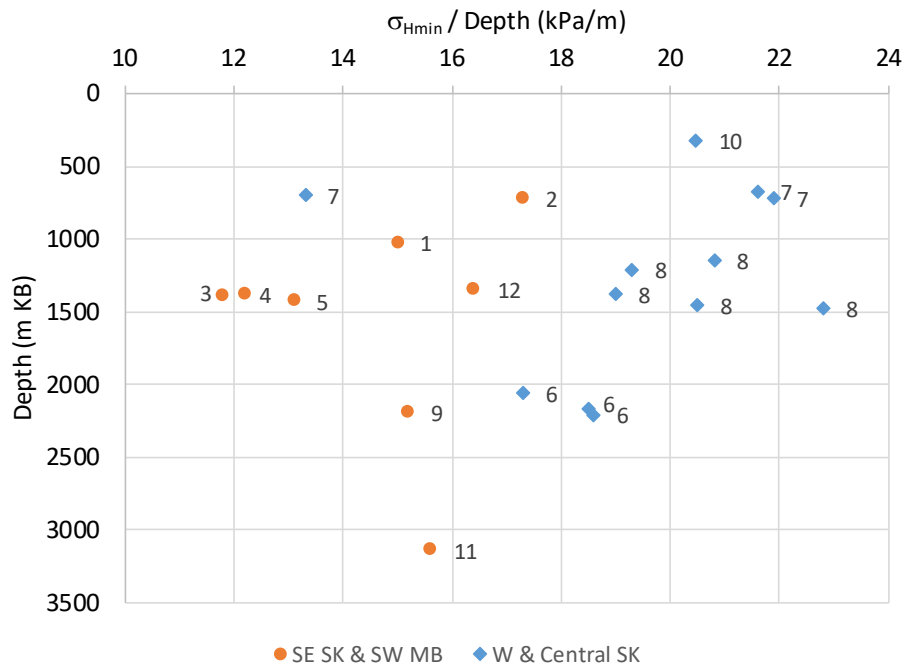


Figure 2: Minimum horizontal stress gradients reported for southern Saskatchewan and southwest Manitoba. The number beside each well is the reference number reported in Table 1.

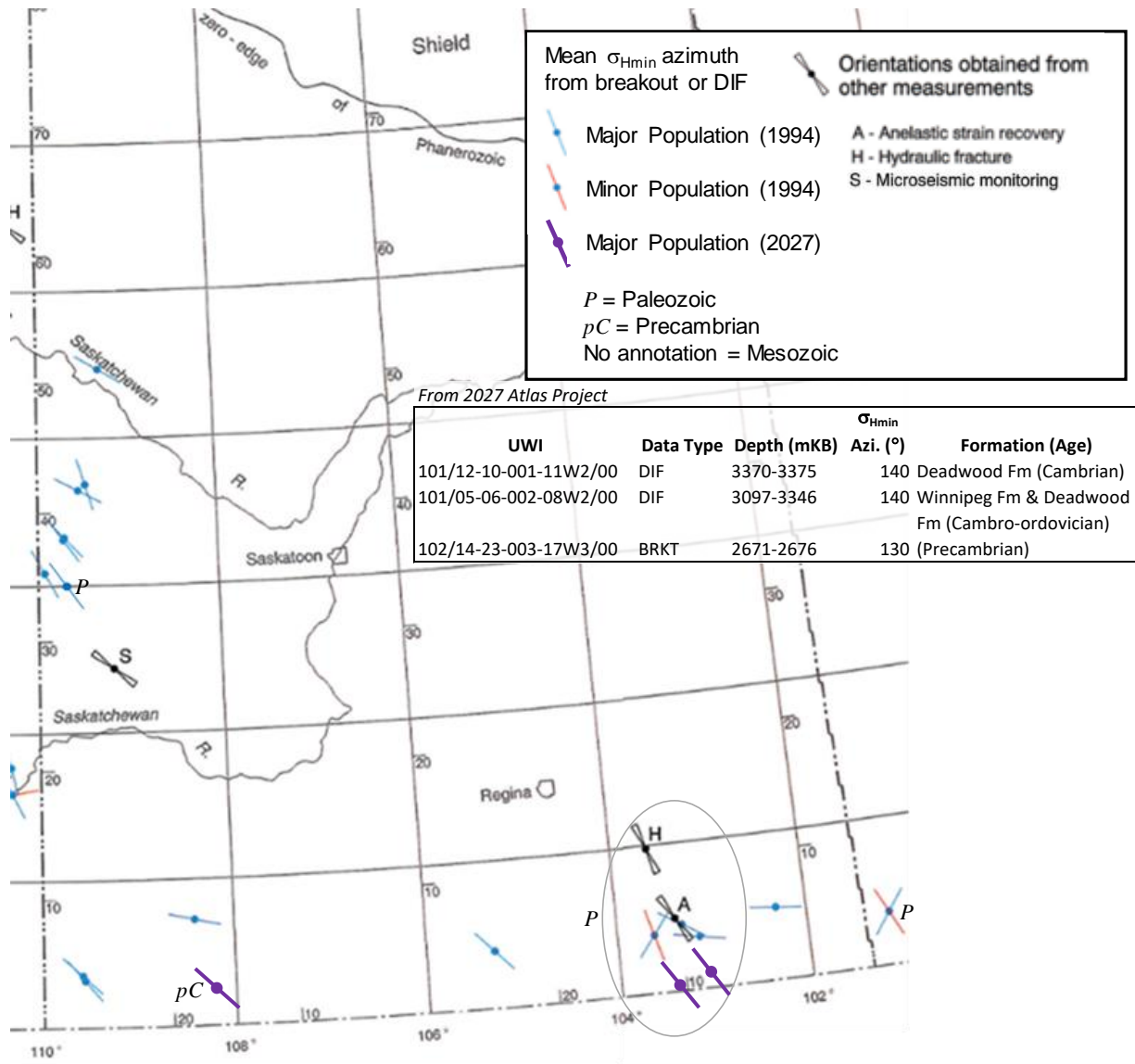


Figure 3: Minimum horizontal stress orientations in southern Saskatchewan and southwest Manitoba. The inset table shows the new data compiled to date for the 2027 Atlas Project. These new measurements were interpreted from drilling-induced fractures (DIFs) and borehole breakouts (BRKTs) observed in borehole image logs.