

2WS: Where are the Sweet Spots and How can we Convert Resource to Reserves?

Belinda Hicks

Husky Oil Operations Limited, Calgary, AB, Canada

The Turonian Second White Specks (2WS) and time equivalent Favel Formations are rich petroleum source rocks deposited during a period of sea level rise of the Western Interior and Hudson seaways of the Western Canadian Sedimentary Basin (Fig. 1). The organic rich claystones and basinal limestones comprising these formations and their lateral equivalents were deposited from Alberta to Manitoba and as far south as the Gulf of Mexico (Greenhorn Sea). Mixing of colder low salinity Boreal waters with warmer, normal salinity, southern Tethys ocean waters occurred during this transgression. Limited presence of benthic fauna, a lack of significant bioturbation, the presence of pyrite and a high degree of organic matter preservation are characteristic of this interval and are thought to be consistent with conditions of widespread bottom water anoxia. The associated shorelines for these fine grained, calcareous shelf deposits, within the Western Canadian Sedimentary Basin (WCSB) are interpreted to be either west of the current disturbed belt in British Columbia, or to the southwest, in Montana. Shoreline sediments have been eroded on the eastern margin of the basin, in Manitoba.

The contact between the 2WS/Favel Formations and the underlying Belle Fourche Formation can be conformable, or may be marked by an unconformity in some areas (Fig. 1). This contact is characterized by a marked increase in carbonate content associated with abundant coccoliths (white specks) and an increased abundance of *Inoceramus*. In some areas the contact between the 2WS and the Belle Fourche is marked by the presence of a thin bioclastic debris bed. The 2WS/Favel Formations are conformably overlain by Colorado shales in Alberta and Western Saskatchewan and by the Carlile shales in Eastern Saskatchewan and Manitoba. The disappearance of the white specks, and a corresponding decrease in grain size, mark this transition. On logs, this change is evidenced by a decrease in resistivity and an increase in sonic velocity corresponding to the change from more calcareous to more siliceous facies. Paleogeographic maps indicate an increase in carbonate in the 2WS, from west to east. In Manitoba the Favel can be subdivided into the lower Keld Member, which is capped by Laurier limestones, and the upper Assiniboine Member, which is capped by the Marco Calcarenite. Thicknesses of the 2WS/Favel Formations range from 25m in Manitoba to greater than 90m in northwest Alberta. The Favel Formation outcrops along the Manitoba Escarpment and regional dip of the Favel/2WS is to the west towards the disturbed belt.

A variety of play types exist across this vast system including biogenic gas, oil shale, light oil, and very minor amounts of thermogenic gas. Thermal maturities in the WCSB trend from immature in the east to overmature in the west (Fig. 2). Organic matter is primarily type II oil prone kerogen with some localized occurrences of type III, particularly to the northwest, associated with an increased influx of terrigenous clastics. Very little terrigenous input is associated with the eastern margin of the Hudson Seaway. Average TOC values range from <0.5 to 12 wt%. Mineralogical data for the play is more limited but generally this zone consists primarily of quartz, calcite (up to 31%), minor dolomite, and varying amounts of kaolinite, illite-smectite and chlorite.

Despite the vast aerial extent of organic rich shales deposited at 2WS time in the WCSB, production from this interval has been limited to only a few areas within the depositional fairway (Fig. 2). Exploration efforts in Manitoba and Saskatchewan have met with limited to no success. Thermal maturity has been one limiting factor with a significant portion of this trend having not been buried deeply enough for significant volumes of hydrocarbon generation. Localized areas of increased thermal maturity may yet be found. High clay content and ineffective stimulation techniques most likely play a key role in limiting production. Undiscovered accumulations of biogenic gas may exist in thermally immature areas and the search continues for transgressive sand bodies with more conventional reservoir characteristics within this interval in Saskatchewan. With the recent interest in oil resource

plays, more attention should be focused on solving the dilemma of finding and extracting more hydrocarbons from this huge resource in Alberta.

PERIOD	STAGE	Southern Plains - AB & W. Sask.	Eastern Saskatchewan	Manitoba Subsurface	Manitoba Outcrop		
CRETACEOUS	Upper	Turonian	Niobrara Formation				
			Cardile Formation	Boyne Member	Boyne Member	Boyne Member	Chalky Unit
				Morden Member	Morden Member	Morden Member	Calcareous Shale Unit
			Favel Formation	Second White Specks	Assiniboine Member	Assiniboine Member	Morden Member
					Keld Member	Keld Member	Marco Calcarenite
			Lower	Cenomanian	Belle Fourche Formation	Belle Fourche Formation	Belle Fourche Member
	Fish Scale Formation	Fish Scale Formation			Fish Scale Zone	Base of Fish Scale marker	
	Westgate Formation	Westgate Formation			Westgate Member	Westgate Member	
		Newcastle Formation			Newcastle Member	Skull Creek Member	
		Viking Sandstone					
		Joli Fou Formation					

(after Bloch et al 1999, Williston Basin TGI II)

Figure 1

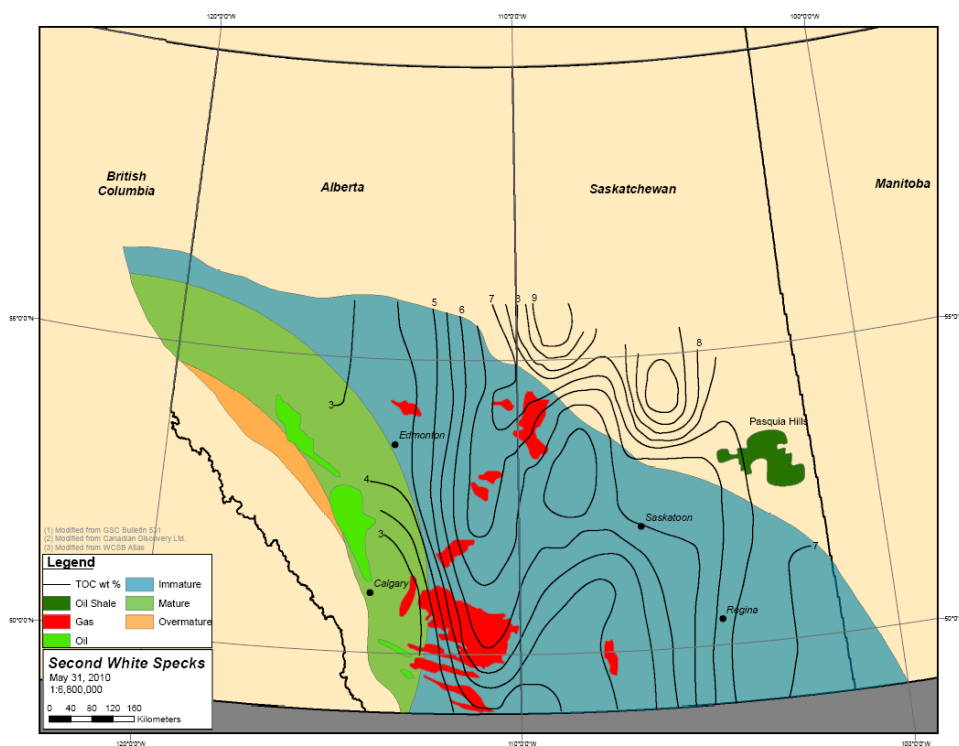


Figure 2

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