The Sydney Basin occupied a strategic location on the margin of the North American craton in the Late Paleozoic, athwart the St. Lawrence Promontory of the Appalachian Orogen and closely adjacent to the Meguma Terrane, originally part of the Gondwana continent. The rhomb-shaped basin was bounded by strike-slip faults, many of which splayed from the Minas Geofracture along which the Meguma Terrane was emplaced. The collisional history of the two continents may thus be reflected in the basin's stratigraphic succession.

The basinal fill, about 4 km thick, spans 75 Ma from the Tournaisian to the Permian and consists of two fining-upward megasequences, separated by a hiatus. The lower megasequence (Horton, Windsor and Canso groups) contains fanglomerates derived from a series of small basement blocks bounded by active strike-slip faults. The upper megasequence (Marien Group and overlying redbeds) consists of coal-bearing alluvial strata, deposited from a long-lived, NE-flowing drainage system. Local faults were inactive but activity continued on the Minas Geofracture and its splays. The intervening hiatus, about 22 Ma in duration involved uplift, erosion, karst-weathering and minor deformation.

The fill records two major tectonic pulses, which can also be traced across much of the Atlantic region and which are interpreted as distinct phases in the emplacement of the Meguma Terrane. Both pulses resulted in strike-slip activity and subsidence (possibly thermal) which decreased in intensity with time. The hiatus correlates with unconformities and stratigraphic gaps in other basins in the region, with tectonic activity on the Minas Geofracture in southern New Brunswick, and with a thermal phase in the Meguma Terrane. Uplift of the Meguma probably provided the sediment source for the alluvial fill. The increase in abundance of redbeds in Stephanian to Permian time, also observed across the region, may be attributed in part to an increasingly "continental" climate as the two landmasses amalgamated.

The basin's position over the St. Lawrence Promontory, where a NW-trending dislocation appears to underlie the Laurentian Channel, suggests that a long-lived fracture system cutting the North American craton (a transform fault?) also may have governed the location of the basin.