



Topic 10: **GEOLOGY of SYDNEY REGION**

Did you know that,

- Sydney lays in a triangular-shaped basin that extends from near Batemans Bay to north-east of Newcastle and inland to Ulan.
- The basin rocks continue east of the coast to form part of the continental shelf.
- The sedimentary rocks of the Sydney basin were deposited about 220 million years ago.

The geological features and development of the landscape of northern Sydney and the Ku-ring-gai Wildflower Garden are understood when considered as part of the evolution of the geological Sydney Basin. Two major aspects of geology are essential for this: determining the occurrence in depth of the rock units, the basic third dimension of geology, and, especially, deducing the sequence of events and processes which occurred through time to form the basin, for time is the vital fourth dimension of the science of geology. The distinctive geological province is also one of the 80 bioregions of Australia identified in the co-operative study led by the Australian Natural Conservation Agency.

The Sydney Basin rocks continue beneath the Jurassic strata and Cenozoic (Cainozoic) volcanics of the Liverpool Range beyond the Hunter Valley, to broaden into the Permo-Triassic Gunnedah Basin, which is also coal bearing. The Gunnedah Basin merges northwards into Queensland's vast Bowen Basin and in doing so, passes beneath the Jurassic Surat Basin, part of Australia's unique Great Artesian Basin.

ROCK AND MINERALS

Unlike most plants, rocks show a continuous gradation in nature and properties especially within the three primary genetic divisions: **sedimentary** - deposited on the earth's surface; igneous - formed by solidification of molten rock (magma); and **metamorphic** - formed by changes in the first two rock types when deeply buried in the earth's crust.

All rocks are aggregates of **mineral** grains, each species of mineral having a regular and distinctive atomic structure and characteristic chemical composition. Four minerals are dominant in common types of rocks.

Quartz [silicon (Si) + oxygen (O)] is stable to weathering.

Feldspar [aluminium (Al) + Si ± sodium (Na) ± potassium (K) ± calcium (Ca) + O] weathers to **clay materials** [Al + Si + O + hydrogen (H)].

Calcite [Ca + carbon(C) + O] forms limestone and marble and weathers by solution.

The dominant **sedimentary rocks** of the Sydney Basin range from exceptionally fine-grained horizons to some with common to abundant pebbles. Except for coal they consist of mineral and rock particles. Well established petrologic nomenclature distinguishes such rocks by the common particle size, into ranges which are:

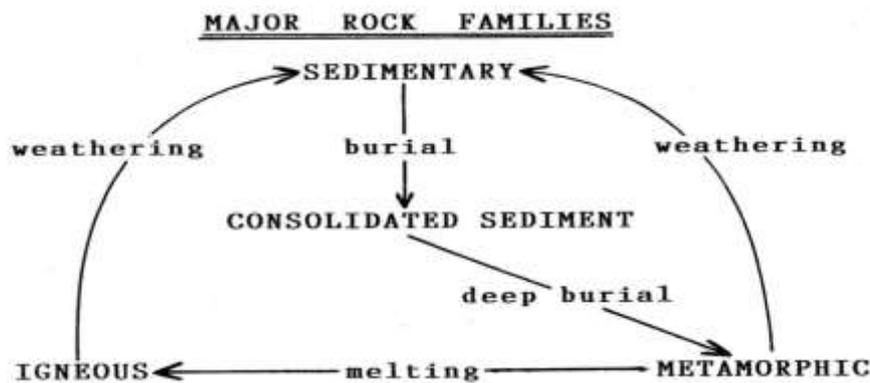
gravel	>2mm	hardening to conglomerate
sand	2-0.05mm	hardening to sandstone, and then to quartzite if a quartz sandstone
silt	0.05-0.005mm	hardening to siltstone

clay <0.005mm hardens to claystone

Clay with some silt hardens to mudstone; while shale is mudstone and claystone with parallel breaking due to sub-parallel alignment of the flat clay particles under the compression of deep burial.

MAJOR ROCK-FORMING MINERALS

<u>MINERAL</u>		<u>WEATHERING TO</u>
QUARTZ	SiO ₂	STABLE
FELDSPAR	Na, K, Ca, Al, Si, O	CLAY
DARK MINERALS	Fe, Mg, Ca, Si, O	CLAY MINERALS
CALCITE	CaCO ₃	DISSOLVES
CLAY MINERALS	Al, Si, O, H(Na, K, Ca, Mg...)	



GEOLOGICAL EVOLUTION

The Sydney Basin formed in an extensive depression on older Palaeozoic sediments hardened and deformed in deep burial and extensively intruded by granites. Subsequent uplift and erosion exposed these rocks in highlands generally westerly of the present coastline, to provide sources for the simple succession of distinctive sedimentary layers deposited in the depression. Tilting of the region during this deposition changed source areas of the sediments, the Narrabeen Group being derived from the north and the overlying Hawkesbury Sandstone from southerly sources.

PERMIAN

The oldest (lowest) sediments are of Permian (299-252 million years) age. Seed ferns and conifers had just become abundant on earth, and accumulated into thick peat-like layers which with burial were progressively transformed into black coal. The Greta Seam, long mined at Cessnock and Kurri, is up to 11m thick, and occurs within sediments deposited in fresh water producing coals low in sulphur. The paucity of outcrop in the middle Hunter Valley of both this seam and the enclosing rocks led to geological mapping in the 1880's which elucidated the basic geological column and structure of the Basin.

GEOLOGICAL TIME SCALE

<u>ERA</u>	<u>PERIOD</u> (from fossil associations)	<u>AGE(MyBP*)</u> (from radioactive decay)	<u>IN NSW</u>
CAINOZOIC	Quaternary		Coastal
	Tertiary	1.6	Basalts; Murray Basin
MESOZOIC	Cretaceous	65 M	Northern NSW basins
	Jurassic	145 m	" " "
	Triassic	201 m	Upper Sydney Basin
	Permian	252 M	Lower Sydney Basin & coal
	Carboniferous	299	North-eastern NSW
PALAEOZOIC	Devonian	362 m	Eastern Highlands basement
	Silurian	408	" " "
	Ordovician	438 m	" " "
	Cambrian	489 m	Far western NSW
	Ediacaran	543	[Flinders Ranges -Ediacara]
	Proterozoic	600	Broken Hill Block
PRECAMBRIAN	Archaean	2500	
	Formation of earth	4550	

(*Millions of years Before Present)

M: Major mass extinction. **m:** Moderate mass extinction

TRIASSIC

There was a fundamental change at the earth surface at the end of the Permian at 252 million years ago. The greatest mass extinction event in recorded geological history reset the botanical clock as well as causing extinction of up to 70% of land vertebrates and 96% of all marine life. The possible causes have generated much research, including at Wollongong University, but on balance it seems that huge volcanic outpourings acidified the atmosphere and oceans creating profound climate change (a lesson for today maybe?). Siberia is believed to have been the most likely culprit. The lush coal measure vegetation of Permian times was largely wiped out and coal ceased to form. Lycopods, including clubmosses, were among the first recolonisers of the land and you can also find horsetails (Equisetales) among the Triassic fossils of the Northern Beach rock platforms. Conifers re-established themselves through Middle Triassic times.

Narrabeen Group.

This lowest Triassic unit consists of a thick (up to 700 m) sequence of sandstones and conglomerates, claystones and laminites. There was a strong input of fine volcanic debris in the south while in the Hunter region, coarse gravels flooded down from the rising New England mountain front in the form of molasse deposits, thinning and fining out to coarse sandstones southwards. Strata of the Narrabeen group form the cliffs from Long Reef to Barrenjoey, most of the Central Coast coastline and hinterland including the Watagans, the steep slopes and cliffs in the southern part of Royal National Park and the massive cliff lines of the Greater Blue Mountains.

Hawkesbury Sandstone. This prominent sandstone directly overlies the Narrabeen Group and forms the bedrock of the Ku-ring-gai Wildflower Garden. The dominant relatively pure quartzose sandstone produces the sandy soils, especially on the flat ridgetops. When deeply buried, crystallisation and recrystallization of the constituent quartz has produced sandstone with a range of hardness. Part is now solid hard quartzite. In some bands with residual porosity the quartz sand grains developed overgrowths extending into cavities between the grains, forming crystals whose minute faces sparkle in the sunshine. Alluvial to deltaic formation of the sands is evident from the common current bedding, which also shows that the direction in which water flowed during deposition was dominantly north-easterly. Red-brown concentric bands and patchy coloration in the sandstone have formed subsequent to deposition, being produced during weathering by precipitation of iron oxide mobilised in ground water. This cuts across primary bedding and is not banding related to the deposition.

Wianamatta Group. These shales in turn overlie the Hawkesbury Sandstone. In our northern suburbs these have been eroded away except on flat ridgetops where this rock type formed superior soils, once forested and subsequently the site of orchards early settlers. The boundary between Hawkesbury Sandstone and overlying Wianamatta Group steadily decreases in height south-west from the Pacific Highway to below sea level. The subdued topography south of the Parramatta River thus preserves Wianamatta (Ashfield) shale at the surface with Hawkesbury sandstone in depth, whilst rising easterly and southerly to the surface to form the prominent coastal cliffs along a narrow strip from Drummoyne to South Head and southwards along the coast.

TOPOGRAPHY

From northern Sydney to the Hawkesbury River and beyond, the Hawkesbury Sandstone is the sole to dominant rock and, being resistant to erosion, its upper surface preserves on ridgetops the level of a former plain warped upwards to form the Hornsby Plateau. Two features of it have a major control of the pattern of erosion and topography. These, together with aspect, have a marked effect on the types of vegetation and the plant associations.

Vertical joints (fractures) through the sandstone commonly are in an approximately rectangular array. Blocks breaking away along the joints create the vertical cliff faces, while the common north-east and north-west joint orientation controls the overall directions and offsets of the Hawkesbury River and its tributaries. In addition, the sandstone contains softer thin horizontal shale layers of limited lateral extent, especially in the upper part. Sandstone breaking off along joints over such shales forms vertical cliffs whose retreat above the shale lens creates a relatively flat shelf in the topographic profile, onto which the impervious shale directs ground water from the overlying sandstone. The soil on such steps contains clay derived from the thin shale, retaining moisture, and may develop a distinct vegetation or even form a perched swamp. The flat area of Lambert's Clearing formed this way.

The cycle developing the present topography began with uplift and warping of the region, deforming the consolidated sedimentary sequence into a basin, and exposing it to weathering and erosion.

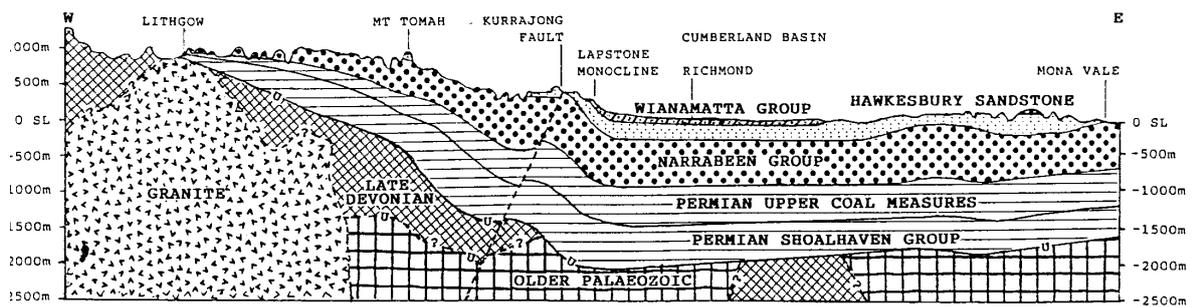
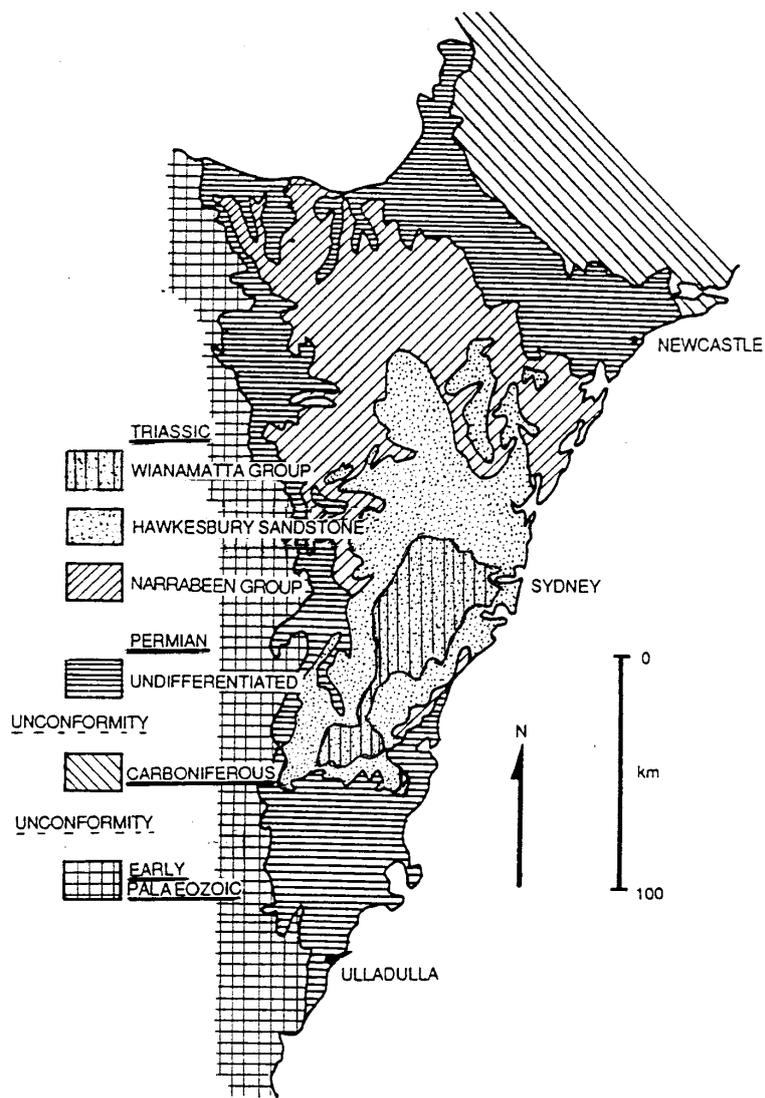
Prolonged ancient weathering in previous climates resulted in cumulative concentration of iron oxide in the subsoil as nodules and irregular cementation, still preserved on the flat ridge tops where slight erosion since then has exposed this ironstone as a brown gravel which is restricted to the older surface of the Hornsby Plateau. Mobile iron oxide has locally precipitated in thin concentric bands between joints staining them red-brown, and less commonly as brown veinlets in micro-fractures and along joints. Both features are well developed at White Horse Beach, West Head. Large boulders of sandstone can also exhibit "case hardening", in which a thin outer skin is preferentially cemented by surface evaporation of pore water depositing oxides dissolved in small amounts from the interior. When part of this skin is broken and lost, the softer often friable sandstone beneath it is easily eroded to create a cavity within the boulder.

The erosion cycle developing the present topography began with the warping of the Sydney Basin, together with selective uplift. From this came the extraordinary courses of the Nepean and Hawkesbury Rivers. Both now flow from low flat topography into gorges cut into substantially uplifted areas, despite the low sections having no topographic hindrance to a short flat route from Penrith eastwards to the Parramatta River. The present river courses through gorges are simply the paths before uplift commenced, and erosion of the river beds was sufficient to maintain these courses during the uplifts.

The final stage of evolution of our landscape was the substantial rise in sea level at the end of the recent Ice Age. Major melting of the extensive glaciers (including at Mt Kosciusko) and of the polar ice caps about 15,000-20,000 years ago, produced a geologically rapid rise in sea level of about 100m. Before this occurred, the early aborigines saw a wide low coastal plain extending considerably east of the present shore line of Sydney. The Parramatta River and Hawkesbury River flowed along river flats before crossing the coastal plain to the sea. This was unknown to the original white settlers.

Confirmation of the substantial recent rise of sea level, proposed by Charles Darwin for the origin of coral atolls in the western Pacific Ocean, and creating the deep drowned river valleys and scenic bays prominent in the Sydney Basin, was an early achievement of Australian science.

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Geological map of the Sydney Basin, and a W-E section from Lithgow to Mona Vale. Boundaries marked U in the section are major unconformities.