COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY AND SHIPPING.
F. A. O'CONNOR, *Secretary*.

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS.
H. G. RAGGATT, *Director*.

BULLETIN No. 7
(MISCELLANEOUS SERIES No. 3).

A STUDY OF AUSTRALIAN DIATOMITES WITH SPECIAL REFERENCE TO THEIR POSSIBLE VALUE AS FILTER MEDIA

BY

IRENE CRESPIN, B.A.,
Commonwealth Palaeontologist.

Issued under the authority of Senator the Honorable W. P. ASHLEY,
Minister for Supply and Shipping.

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1. SUMMARY.

The best diatomite marketed in Australia for filtration purposes is that imported from California. This material, which is of marine origin, is extensively treated before being marketed. It contains, as its most important diatoms, the rounded, honeycomb-shaped genus *Coscinodiscus* and the long, needle-like genus *Synedra,* a form which occurs in abundance in the fresh-water diatomites at Lillicur and Moranding in Victoria.

Before the introduction of the Californian diatomite into the world's markets, English consumers regarded diatomite composed of boat-shaped or spindle-like forms as most suitable for filtration. A diatomite with these characteristics is to be found at Lillicur and Moranding in Victoria, and during the 1914-18 war considerable efforts were made to introduce the Lillicur diatomite into the British market, but at the time freight rates were prohibitive.

Samples from 46 deposits of the known 76 occurrences of diatomite in Australia have been micropalaeontologically examined, and 27 genera of diatoms represented by 48 species have been identified from them. The distribution of these species in the various diatomites is given in Table II.

The following tentative conclusions with regard to the suitability of Australian diatomites for filtration purposes are based on a study of the shapes and sizes of the contained diatoms, in accordance with English and Californian experience.

The diatomites with the best possibilities are at Lillicur, Moranding and Happy Valley near Linton in Victoria, and at Grassmere (Ewart's Swamp and at a locality 6 miles from Grassmere) in the Albany district, Lake Gnangarra and Chinaman's Swamp in the Waneroo district and in the bed of the Arrowsmith River, Arrino in the Mingenew district in Western Australia. It is understood, however, that these Western Australian deposits are small in extent. The blending of diatomites from different deposits in Victoria such as those at Allestrie near Portland, and Newham near Woodend with Lillicur and Moranding material, would considerably increase the filtering properties of the diatomite from the latter localities, because of the additional varieties of shapes and sizes of the diatoms.

Extensive deposits of diatomite, which are dominated by the diatom *Melosira* and which are suitable for purposes other than filtration, are available in Queensland and New South Wales. Nevertheless, this type of diatomite is used successfully by Davis Gelatine (Australia) Ltd., as a filter medium.

The commercial value of a diatomite as a filter aid, which depends on the amount necessary to give a perfectly clear filtrate, the speed of filtration, and the character of the press-cake and similar criteria, can only be satisfactorily determined by actual experiment. It is also necessary to establish a correlation between the characters determined by microscopic examination and actual filtration tests before a final conclusion can be stated.

It is apparent from the considerable variation noted in specimens of diatomite from the same deposit that in most cases selective mining will be necessary to enable a uniform product to be marketed. Also, more field work and testing are required to establish the extent of those deposits from which it appears that the best quality diatomite may be obtained.

2. INTRODUCTION.

Diatomite is a sedimentary rock resembling chalk in appearance and is composed largely or wholly of skeletal remains of minute, flowerless, aquatic plants called diatoms which are related to algae. Each diatom consists of a single cell and secretes a siliceous case known as the frustule, which is composed of two valves arranged like the lid and bottom of a box. In some species the individual cells are attached together, forming chains or colonies.

Diatomite is extremely light in weight. In dry block form it has an apparent specific gravity of 0.40 to 0.60 and in dry powder from 0.08 to 0.25, but its true specific gravity is 1.19 to 2.35. It may vary from soft, powdery material to hard compact rock according to the conditions under which it is formed, and it may be of fresh-water or marine origin. It occurs chiefly in deposits of Tertiary and Recent age, but research in America has proved a small deposit in the Upper Cretaceous of California. The diatomite found in Tertiary deposits is white, cream or buff-coloured and, if of fresh-water origin, is usually associated with volcanic rocks. Diatomites of Recent age are associated with swamps and lakes, soaks and springs and are frequently referred to as "diatomaceous mud or peat". They vary in colour from light to dark grey, buff, brown or black.

Diatomite is also known as diatomaceous earth, diatomaceous silica, kieselguhr, infusorial earth, tripolite and tripoli. "Kieselguhr" is the name that was given to the first diatomite mined in Hanover, Germany, in 1860. It is also used in some industries to signify diatomite that has been treated. "Infusorial earth" is a misnomer as the infusoria are a group of the animal kingdom. The name "Tripolite" is derived from the diatomite originally mined at Tripoli in North Africa. "Tripoli" is the name correctly applied to the white, finely granular, porous, siliceous rock formed by the weathering or alteration of chert or flint, or by the decomposition of siliceous limestone, and should not be applied to diatomite. It is sometimes used as a trade name.

The demand for diatomite in industry in Australia and elsewhere has increased greatly during the last two decades. Although numerous deposits are recorded in all Australian States except Northern Territory, diatomites suitable for filtration purposes are regarded as limited in occurrence. Consequently diatomite for such purposes has been imported, principally from California. Owing to the uncertain conditions during the war years, it was found necessary to investigate further the properties of the Australian and New Zealand diatomites, especially for use as filter media. A small quantity of Australian diatomite has been used for this purpose since 1922. This report presents the results of a study of the shapes and sizes of diatoms in Australian diatomites, these being important factors in determining the suitability of a diatomite as a filter medium.

Other aspects of the diatomite industry in Australia have been discussed in the Summary Report on Diatomite issued by the Bureau of Mineral Resources (Crespin, 1946).

Chemical analyses of diatomites from various localities in America and Australia are given in Table I. It will be noted that the silica content of the highest grade diatomite suitable for filtration purposes in Australia, which comes from Lillicur, Victoria and is of fresh-water origin, compares favorably with that of the well known marine diatomite from Lompoc, California. At the same time the moisture content of the Australian product is considerably higher than that in the American one. An analysis of the *Melosira* diatomite from Quesnel, Canada, is included for comparison with this type from Queensland and New South Wales.

TABLE I.

ANALYSES OF SOME REPRESENTATIVE DIATOMITES.

—	1.	2.	3.	4.	5.	6.	7.
Silica	88.68	83.20	80.00	84.14	88.01	85.15	49.08
Alumina ..	2.68	3.80	2.70	1.30	0.34	4.44	3.51
Iron oxide ..	trace	3.00	1.00	0.90	0.31	trace	..
Lime	1.61	0 80	1.10	0.30	trace	..	0.16
Magnesia ..	1.30	2 23	0.80	0.93	0.10	0.25	0.05
Potash	..	0 89	..	..	..	..	..
Soda	..	0 33	..	..	..	..	..
Moisture and organic matter..	5.54	5.26	13.40	11.90	10.98	10.16	46.99
	99.81	99.51	99.10	99.47	99 80	100.00	99.79

(1) Lompoc, California, United States of America. (2) Quesnel, British Columbia, Canada. 3) Black Duck, Queensland. (4) Chalk Mountain, Bugaldi, New South Wales. (5) Lillicur, Victoria. (6) Newham, Victoria. (7) Lake Gnangarra, Western Australia.

The above analyses were obtained from the following sources:—Nos. 1 and 2 from Eardley-Wilmot (1928); No. 3 from Ball (1927); No. 4 from Kenny (1924); No. 5 from Abrazite Mineral Products and No. 6 from G. & A. Thomson (analyses by Government Assayer, Mines Department, Melbourne, in 1946 and 1936 respectively); No. 7 from Simpson (1903).

3. USES OF DIATOMITE.

The commercial value of diatomite lies in its porosity and its chemical inertness, the latter being due to the fact that it is composed almost wholly of silica. The two most important uses of diatomite are as a filtering medium and as an insulator against heat, cold and sound. (Eardley-Wilmot, 1928; Skinner, &c., 1944). In Australia, fillers constitute the third most important use. Until recently the value of diatomite for these purposes was governed primarily by the shape and size of the diatoms it contains. Recent investigation, however, indicated that the distribution of the particle size and the process treatment of the diatomite are also important factors. (Skinner, &c., 1944). For filtering purposes a mixed assemblage of long, thin, needle-like and rounded, honeycomb-shaped diatoms, such as are found in diatomites of marine origin, is preferred. Small rod-like, thin and stout ovate, cylindrical and naviculoid (boat-shaped) forms, which comprise many of the fresh-water diatomites, are suitable for other purposes. Fresh-water diatoms are tougher than marine forms and, therefore, are especially useful in the manufacture of abrasives.

For use as a filter-aid, two important factors have to be considered in the selection of a suitable diatomite. The first is its effect on clarity and rate of flow of the filtrate; the second is whether the cost of the filter-aid can be offset by the production of better products or by an increased output.

Powdered diatomite is generally used as a filter-aid in conjunction with ordinary filters or presses, the cloths or plates of which, after a short period of use, act as a backing or retainer for the diatomite. The usual practice in large-scale operations for filtering many liquids is to "precoat" the filter cloths with a layer of diatomite. The diatomite builds up a solid cake on the cloth, forming a reinforcing wall of highly porous material. The flow from the pre-coat vat is then shut off and the crude liquors from the main storage vats are passed through. Also in most instances small amounts of diatomite are added continually to the crude liquors in the main vat which are kept well agitated. This ensures a gradual and more efficient building up of a filter cake and tends, not only to keep it open and porous and thus permit free passage of the fluids, but also to facilitate greatly the clean removal of the cake.

The high porosity of diatomite makes it a highly efficient filtrant, and its chemical inertness enables its use for filtering a great variety of liquids. By far the largest proportion of diatomite consumed in filtration is in the clarification of sugar. Minor amounts are employed in the filtration of crude oils, used oils, dry-cleaning fluids, wine, beer, fruit juices, water, pharmaceutical products and metallurgical solutions. Diatomite has been used extensively by the Armed Services for filtration of water used by personnel stationed in and around Australia.

The importance of the insulating properties of diatomite against heat, cold and sound is due to its ability to withstand fairly high temperatures and corrosion, and to its high porosity. It is used in several different ways as a semi-refractory heat insulator in furnaces, kilns, glass lohrs (ovens), fireless and electric cookers, evaporators and driers. The principal forms in which diatomite is used for these purposes are bricks and shapes, but it is also used as granule and powder, and, mixed with asbestos and ceramic bonds, as a tamping and mouldable material for insulating flues and pipes. Semi-refractory cements are available for use with bricks and granules. In general these products are used where temperatures between 800 to 1,000 degrees Centigrade are involved.

Diatomite is being successfully substituted for cork in refrigeration chambers and units. It is also used in tanks for storage of petroleum products, in safes, and in floors and walls of buildings.

Diatomite is utilized in the manufacture of certain building materials, e.g. tiles, artificial stone, wall board for sound proofing, and concrete; as a filler, e.g., in smoke mixtures, kalsomines, drugs, paints, accumulator cases, rubber, plastics, phonograph records and insecticides; in mild abrasives, e.g., metal polishes, dental powders and scouring compounds; and as an absorbent, e.g., for catalysts, explosives, dry insecticides and fertilizers.

4. PREPARATION OF SAMPLES FOR MICRO-EXAMINATION.

The presence of diatoms in a supposed diatomite can only be determined by microscopic examination. Many forms can be identified with a magnification of 200 diameters. The minuteness of the diatom is illustrated by the fact that the unit of measurement used in describing them is the micron, which is equal to a thousandth part of a millimetre. It has been estimated that from 40,000,000 to 70,000,000 diatoms are present in one cubic inch of diatomite.

A preliminary examination can be made by suspending a small amount of diatomite (about as much as will cover the end of the blade of a penknife) in a large quantity of water. After stirring (i.e. without permitting the solution to settle) place a drop of the liquid on a micro-slide and mount with a cover-slip.

Another simple method of preparation for a more or less detailed examination, is to suspend a small amount of powdered diatomite (as stated above) in water in a test tube. This should be shaken well so as to disintergrate the minute particles and free the diatoms. The solution is allowed to settle for a few moments. The amount of residue in the bottom of the tube will give some indication of the purity of the diatomite. A drop of the liquid is then taken from above the sediment by means of a pipette, and placed on a micro-slide and evaporated. It will be found that the diatoms are suspended in the liquid above the sediment, the number of diatoms increasing towards the base of the liquid. The evaporate is then mounted in Canada Balsam.

To prepare a sample for still closer examination and for permanent references, a modification of an earlier method (Eardley-Wilmot, 1928) has been evolved. A small amount of powdered diatomite (as stated above) is placed in a beaker to which is added a small quantity of a 15 per cent. sodium carbonate solution. This is boiled for 10 to 15 minutes to separate the diatoms from the clayey matrix, and then filtered. The filtered material is washed into a beaker and a small quantity of 50 per cent. nitric acid added. A small amount of potassium dichromate is also added to oxidize organic matter. The solution is boiled for 10 to 15 minutes, filtered and the filtrate washed until clean. The washed material is transferred to a test tube and allowed to settle for two or three minutes. A drop of the liquid from above the sediment is placed on a micro-slide and evaporated. When dry, the evaporate is mounted in Canada Balsam, Styrax or Sirax.

In the subsequent microscopic examination the following are points to which particular attention should be paid:—

(*a*) The amount of impurities present.

(*b*) The proportion of the large and the small diatoms.

(*c*) The percentage of fragments and the extent of fracture of the diatoms.

(*d*) Uniformity of size and shape of the diatoms.

5. TYPES OF DIATOMS IN AUSTRALIAN DEPOSITS.

Diatoms, both living and fossil, are of world-wide distribution and are found under both marine and fresh-water conditions. However, it is only microscopic examination that can determine whether a diatomite is of marine or fresh-water origin. Although some genera of diatoms are found in both salt and fresh water, most of them are exclusive to one or the other. For the most part it is found that the long spindle-shaped diatoms are characteristic of fresh water and the disc-like ones of salt water. Diatoms live in all types of water, from hot springs to the cold waters of the polar regions, at depths varying from 10 to 75 fathoms according to the penetration of light. They have their greatest development in cold waters.

Fossils diatoms, both of marine and fresh-water habitat, are widely distributed in deposits of Tertiary age. The fresh-water diatomites are usually associated with volcanic rocks, and it is thought that the volcanic activity with which these rocks are connected furnishes silica to the water which the diatoms extract to build up their siliceous skeletons.

The best known and most publicized diatomite deposit to be worked for filter media is in the United States of America at Lompoc, County Barbara, California. The diatoms in this deposit, which is of marine origin, consist of the rounded, honeycomb-shaped forms such as *Coscinodiscus* and the long, needle-like genus *Synedra,* a form found living under both fresh-water and marine conditions.

All known occurrences of diatomite in Australia are of fresh-water origin. However, some of these fresh-water diatomites have proved good filter media. The ideal for normal filtration requirements would be a mixture of such rod-like genera as *Eunotia,* thin forms like *Tabellaria* and *Gomphonema,* ovate forms such as *Pinnularia, Amphora* and *Surrirella* and naviculoid (boat-shaped) genera like *Navicula, Cymbella* and *Neidium.* These genera of diatoms are found in Australian diatomites and many of them are illustrated in Plates 1 to 5.

The identification of 27 genera of diatoms has been made in the Australian diatomites and these are represented by 48 species. These forms with their distribution in the diatomites from various localities are given in Table II.

6. NOTES ON THE DIATOMS AND DIATOM ASSEMBLAGES IN AUSTRALIAN DIATOMITES.

A few notes on the ecology of some of the genera of diatoms which are characteristic of fresh-water diatomites will illustrate how the origin of a deposit can be inferred from the diatom assemblages it contains.

Diatoms cannot live in muddy water and they must have light. The amount of light, the weather, temperature and food supply, all affect the rapidity of growth and increase of forms (Taylor, 1929).

DISTRIBUTION OF DIATOMS IN AUSTRALIAN DIATOMITES.

Diatoms.	Localities.																																													
	Queensland.							New South Wales.								Victoria.								Tasmania.			South Australia.	Western Australia.																		
	Innot Hot Spr.	Cunjeboy.	Planet Downs.	Junee.	Black Duck	Tabletop.	Numinbah.	Tintenbar.	Wyrallah.	Bell's Mt.	Nandewar Ra.	Chalk Mt.	Cooma.	Cudal.	Merriwa.	Lillicur.	Talbot.	Moranding.	Newham.	Happy Valley.	Mickleham	Allestree	South Yarra.	Nr. Andover.	Fonthill.	Bishopsbourne.	8 mile Ck. Swp.	Cape Riche.	Cheyne Beach.	Grassmere.	Ewart's Swamp.	Jakanna Creek.	Millbrook.	Spectacles Swp.	Herdsman's L.	L. Gnangarra.	Lt. Badgerup.	L. Badgerup.	L. Jandabup.	L. Mariginiup.	Chinaman's Swp.	Bullsbrook.	Arrino.	Mingenew Spr.	Eyeregulla Spr.	Moriarty Spr.
Amphipleura sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphora obtusa Greg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	r	r	r	r	—	r	—	f	f	r	r	r	r	r	f	—	—	—
Amphora ovalis Kutz.	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	r	r	—	—	—	—	—	r	—	—	—	—	—	—	r	—	r
Amphora robusta Greg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—
Amphora sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—
Biddulphia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cocconeis placentula Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	c	c	c	c	c	—	—	r	—	—	r	—	r	—	r	—	—	r	—	—	—	—	r	—	—	—	—	—	—	—
Cyclotella sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymbella asper (Ehr.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymbella heteropleura Kutz.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	f	r	—	r	—	f	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cymbella ventricosa Kutz.	r	r	—	—	r	—	—	f	f	—	—	—	—	r	—	f	f	f	r	—	—	f	r	—	r	r	c	—	r	f	f	r	—	—	—	r	f	r	—	r	—	r	r	—	r	—
Diatoma vulgare Bory	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	r	—	—	r	—	—	r	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diatomella sp.	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diploneis elliptica (Kutz.)	c	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	r	f	r	r	—	—	—	—	—	r	r	—	f	c	—	r	—
Epithemia gibbula var. *producta* Grun.	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	a	c	r
Epithemia turgida (Ehr.)	f	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	f	—	—	r	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eunotia gracilis (Ehr.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eunotia major (Wm. Sm.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	f	r	r	—	f	r	—	—	c	f	f	f	f	f	f	c	—	—	c	—	—	r	—	c	c	c	—	r	—
Eunotia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fragilaria harrisoni (Wm. Sm.)	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	r	f	f	a	—	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Frustula rhomboides (Ehr.) var. *amphipleuroides* Grun.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	—	—	—	—	—	—	f	—	—	—	—	—	—	f	—	—	—
Gomphonema acuminatum var. *coronatum* (Ehr.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	f	—	—	f	—	—	—	r	—	—	r	r	r	—	r	—	f	—	r	—	—	—	—	—	—	—	—	—
Gomphonema intricatum Kutz.	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	c	f	c	—	r	r	c	—	—	—	f	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—
Hantzschia sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	f	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mastogloia cf. *smithi* Thw.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	a	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Melosira granulata (Ehr.)	—	a	a	a	a	c	f	c	a	a	a	a	a	a	a	r	r	r	a	r	c.	f	—	a	r	a	—	—	—	r	—	—	r	—	r	r	r	r	r	—	r	—	r	—	—	—
Navicula cuspidata Kutz. var. *ambigua* Ehr.	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Navicula maculata Bailey	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	r	c	c	—	r	r	—	—	—	—	—	r	—	—	f	—	—	—
Navicula semen Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Navicula sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	a	a	—	—	r	f	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neidium iridus (Ehr.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	r	—	—	c	c	c	c	—	—	—	—	—	—	c	—	—	—	—	—	f	—	r	r	—
Nitzschia amphibia Grun.	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	f	—	—
Nitzschia insignis Greg.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nitzschia cf. *spectabilis* Grun.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	r	—
Pinnularia cf. *acrosphaeria* (Breb.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pinnularia gibba (Kutz.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—
Pinnularia legumen Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—
Pinnularia major (Kutz.)	r	—	—	—	—	—	—	f	r	—	—	—	—	—	—	—	—	—	r	—	—	—	—	r	r	r	—	f	r	f	r	r	r	r	r	r	—	—	r	—	r	r	f	—	—	f
Pinnularia nobilis Ehr.	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	c	f	r	—	—	—	r	f	—	—	—	—	r	—	—	f	—	—	—	—	r	c	c	—	—	—	r	—	f	—	r
Pinnularia cf. *parva* (Ehr.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhopalodia gibba (Kutz.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	r	r	—	—	—	—	f	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rhopalodia ventricosa (Kutz.)	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	f	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scoleotropis latestriata var. *amphora* Cleeve	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	r	f	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—
Stauroneis anceps Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	—	—	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	c	r	f	—	—	—	r	r	—	—
Stauroneis phoenicentron Ehr.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	r	—	—	r	—	—	—	—	f	—	—	—	r	r	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—
Surirella linearis Wm. Sm.	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	—	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Synedra ulna Ehr.	—	—	—	r	—	r	—	f	—	—	—	—	—	—	—	a	c	a	r	c	r	—	—	r	—	f	c	—	f	f	f	f	r	r	—	r	—	—	—	—	—	—	—	—	—	—
Tabellaria fenestrata (Kutz.)	—	r	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	—	r	f	c	—	—	—	—	f	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

a = abundant; c = common; f = few; r = rare. Locality names refer to those marked with * in Section 7.

Melosira does not require as much light as *Synedra* and the association of these two genera in considerable abundance in a deposit is rare. The only deposit in Australia where this association is known is near Bishopsbourne, Tasmania. In Australia diatomites consisting almost entirely of *Melosira* are much more extensive than those containing abundant *Synedra*. The abundance of *Melosira* usually indicates deposition in larger and deeper stretches of water than that required for a diatomite in which *Synedra* is the dominant genus.

Melosira, Fragellaria and *Tabellaria* thrive amongst plankton near the surface of pools and lakes, if sufficient light is available. The only diatomite in Australia in which these three genera are associated in large numbers is at Mickleham, Victoria.

In fresh-water deposits, *Synedra* and smaller forms such as *Stauroneis* and *Navicula* usually indicate deposition in small lakes. This fact may account for the small deposits in the vicinity of Lillicur and Talbot in Victoria, where small shallow lakes may have been present in the irregular surface of the basalt upon which the deposits are now found.

As regards the habitat of the larger fresh-water diatoms, such forms as *Pinnularia* and *Surrirella* grow on the mud at the bottom of ditches, pools and lakes, but do not flourish at depths of more than 50 to 65 feet. It will be noted that these genera are characteristic of the Recent to Sub-Recent lake and swamp deposits in Queensland, Tasmania, South Australia and Western Australia. (*See* Table II.)

At least ten different assemblages of freshwater diatoms can be distinguished in the diatomite deposits of Australia. Some assemblages are restricted to the lake deposits of Tertiary age and others to the deposits associated with swamps, lakes and springs which are Recent to Sub-Recent in age. The assemblages are as follows:—

ASSEMBLAGES.	LOCALITIES.
TERTIARY—	
	Cunjeboy, Planet Downs, Junee, Black Duck, Tabletop, Numbinbah, Queensland; all deposits listed in Section VI. in New South Wales; Andover, Tasmania.
2. *Melosira, Cocconeis,* and other small forms.	Newham, Victoria.
3. *Melosira, Cocconeis, Tabellaria, Fragilaria.*	Mickleham, Victoria.
4. *Melosira, Synedra.*	Bishopsbourne, Tasmania.
5. *Synedra, Cocconeis, Gomphonema,* small *Navicula.*	Lillicur, Moranding, Happy Valley, Victoria
6. *Synedra, Cocconeis, Tabellaria.*	Talbot, Victoria.
RECENT TO SUB-RECENT—	
7. *Diploneis, Diatomella, Epithema.*	Innot Hot Springs, Queensland; Mingenew Spring, Eyeregulla Springs, Moriary Spring, Western Australia.
8. *Mastogloia, Synedra.*	Eight Mile Swamp, South Australia.
9. *Frustula, Neidium, Navicula, Eunotia.*	Lake Gnangarra, Cape Riche, Western Australia.
10. *Pinnularia, Eunotia, Amphora, Diploneis.*	Grassmere and Waneroo (other than Lake Gnangarra) deposits, Western Australia.

The above assemblages can be classified into four groups for general use in determining the age and origin of Australian diatomites—

(1) The deposits in which the diatom *Melosira* dominates the diatom assemblage, as in Queensland and New South Wales.

(2) The deposits in which the long needle-like *Synedra* is abundant, as at Lillicur, Moranding and Happy Valley, in Victoria.

(3) The deposits in which there is a mixed assemblage of ovate, naviculoid and needle-like diatoms, as at Newham, Mickleham and Portland, in Victoria.

(4) The deposits of Recent to Sub-Recent age, all of which contain a similar diatom assemblage, consisting of genera such as *Epithemia, Eunotia, Pinnularia, Amphora, Navicula* and *Diploneis,* as at Innot Hot Springs in Queensland, South Yarra in Victoria, Eight Mile Creek in South Australia, and all occurrences in Western Australia.

7. DISTRIBUTION OF DIATOMITE IN AUSTRALIA.

Fairly extensive deposits of diatomite are recorded from Queensland, New South Wales, Victoria and Western Australia, three small ones from Tasmania and one from South Australia. Up to the present no diatomites have been discovered in the Northern Territory. As far as is known all deposits in New South Wales, and all except one each in Queensland, Victoria and Tasmania, are associated with Tertiary volcanic rocks, chiefly basalts, either in depressions in the lavas or interbedded with them. All other Australian deposits are Recent to Sub-Recent in age and are associated with lakes, swamps or springs.

A list of 76 occurrences of diatomite in Australia is given below. Material from 46 of these localities has been examined microscopically and these are indicated by an asterisk (*). The diatom content of each diatomite is discussed in Section 8, and the distribution of the diatom species in the various diatomites is shown in Table II.

A. Queensland.—Diatomite has been recorded from many localities in the Brisbane district and from as far north as Cairns. All deposits but one are believed to be associated with volcanic rocks. The localities are—

(i) Innot Hot Springs, on Nettle Creek, 8 miles south-east of Mount Garnet, which is 135 miles by rail south-west of Cairns*.

(ii) Cunjeboy, 70 miles south of Mount Garnet*.

(iii) Planet Downs, 60 miles south-east of Comet railway station and 18 miles south-east of Rolleston*.

(iv) Junee, 6 miles north-west of the homestead on Junee property, 40 miles south-west of Ogmore, and 92 miles north-north-west of Rockhampton*.

(v) Black Duck, 25 miles by road south of Gatton, which is 61 miles by rail west of Brisbane*.

(vi) Tabletop on the Darlington Range, near Canungra, 10 miles south of Beaudesert railway station, which is 47 miles south of Brisbane*.

(vii) Numinbah, at the head of Nerang Creek, and 56 miles south-east of Brisbane*.

(viii) Localities in the south-eastern corner of the State—
(a) Rosewood.
(b) Swan Creek.
(c) Emu Creek.
(d) Wonglepong.
(e) Beechmont.
(f) Meerschaum Mountain.

B. New South Wales.—Diatomite deposits are widely distributed in the eastern part of the State. The principal occurrences are in the Lismore-Ballina, Barraba, Coonabarabran, Cooma and Orange districts. In all localities the diatomite is associated with basalt. The localities are—

(i) Lismore-Ballina District—
(a) Tintenbar, 7 miles north-west of Ballina, which is 20 miles south-east of Lismore*.
(b) Wyrallah, 9 miles south of Lismore*.

(ii) Barraba District—
(a) Bell's Mountain, 7 miles north-east of Barraba*.
(b) Nandewar Ranges, 8 to 12 miles north-west of Barraba*.

(iii) Coonabarabran District—
(a) Chalk Mountain, 2½ miles west of Bugaldi, which is 15 miles north-west of Coonabarabran, and 338 miles by rail north-west of Sydney*.
(b) Paddy McCulloch's Mountain, 4 miles south of Bugaldi.
(c) Wantiable Creek, 8 miles east of the village of Tooraweanah, which is 30 miles south-west of Coonabarabran.

(iv) 1.5 miles south-east of Bunyan railway station and 5 miles north of Cooma*.

(v) Cudal, 20 miles north-west of Orange, on the Orange-Cargo road*.

(vi) Small deposits elsewhere in the State—
(a) Merriwa*.
(b) Bungonia.
(c) Cobadah.
(d) Newbridge.
(e) Paddy's River.
(f) Tweed River.
(g) Wellington District.

C. Victoria.—Diatomite deposits are found in the Loddon Valley, in the Ballarat, Mickleham, Woodend, Portland, Lancefield and Bacchus Marsh districts and in some of the suburbs of Melbourne. They are chiefly associated with volcanic rocks. The localities are—

(i) Loddon Valley—
(a) Lillicur on Bet Bet Creek, about 8 miles west of Talbot which is 108 miles by rail north-west of Melbourne*.
(b) Talbot*.
(c) Glengower, 8 miles east-south-east of Talbot.
(d) Daylesford, 75 miles north-west of Melbourne.

(ii) Moranding, about 5 miles north-north-west of Kilmore, which is 43 miles by rail from Melbourne, and immediately west of the Kilmore-Heathcote road*.

(iii) Newham, 9 miles by road north-east from Woodend, which is 49 miles by rail north-west of Melbourne and north of the Woodend-Kilmore road*.

(iv) Happy Valley, 6 miles by road south-east of Linton, which is 15 miles south-south-west of Ballarat*.

(v) Mickleham, 8 miles west of Craigieburn, which is 25 miles north-west of Melbourne*.

(vi) Portland District—

(*a*) Allestrie, about 5 miles north of Portland, near Bell's Creek*.

(*b*) Boomer's Creek, Gorae.

(vii) Melbourne Suburbs—

(*a*) South Yarra*.
(*b*) Fairfield.
(*c*) Brunswick.
(*d*) Northcote.

(viii) Lancefield, 46 miles by rail north-north-west of Melbourne.

(ix) Comaidai, 5 miles north of Bacchus Marsh, which is 32 miles by rail north-west of Melbourne.

(x) Lake McRorie, near Clunes, which is 23 miles by rail north-west of Ballarat.

(xi) Bunker's Hill, 8 miles south-west of Ballarat.

D. Tasmania.—Two deposits of diatomite are recorded from the Midlands and one from near Launceston. The localities are—

(i) A locality 4 miles east of Andover, which is 37 miles north of Hobart*.

(ii) Rushy Lagoon, "Fonthill", Andover*.

(iii) Bishopsbourne, near Longford, which is 15 miles south-west of Launceston*.

E. South Australia.—The only record of diatomite in this State is in the south-eastern portion. The locality is—

(i) Eight Mile Creek Swamp, Section 468, Hundred of McDonell, and 15 miles due south of Mount Gambier*.

F. Western Australia.—Diatomite is recorded from numerous localities in this State. All occur under lake and swamp conditions and are Recent to Sub-Recent in age. The localities are—

(i) Cape Riche, 65 miles east of Albany*.

(ii) Locality 7 miles north of the Whaling Station, Cheyne Beach, and 20 miles west of Cape Riche*.

(iii) Albany District—

(*a*) Grassmere, 6 miles west of Albany*.
(*b*) 18-24 inch layer, Ewart's Swamp, Grassmere*.
(*c*) Jakama Creek, near Albany, on E. A. Hardie's property*.
(*d*) T. Hawley's property, Millbrook*.

(iv) Fremantle District—

(*a*) Spectacles Swamp, Balmanup, 13 miles south-east of Fremantle*.

(*b*) Lake Jilbup, south-east of Fremantle.

(*c*) Lake Walliabup, south-east of Fremantle.

(v) North side of Herdman's Lake, 4 miles north of Perth*.

(vi) Waneroo District—

(*a*) Lake Gnangarra, 11 miles north of Perth and 4 miles north-east of Waneroo*.

(*b*) Little Badgerup Swamp, north-west of Lake Gnangarra*.

(*c*) Lake Badgerup, north of Little Badgerup Swamp*.

(*d*) Lake Jandabup, near Lot 1654, 2 miles north of Lake Badgerup*.

(*e*) Lake Maringiup, north-west of Lake Jandabup*.

(*f*) Chinaman's Swamp, 1 foot from surface of water-hole*.

(*g*) Lake Joondalup.

(*h*) Paul's Swamp.

(vii) Swamp on P. Vesty's property, Bullsbrook, 27 miles north of Perth*.

(viii) Mingenew District—

(*a*) Bed of Arrowsmith River, Block 5182/55, Arrino, 25 miles south-east of Mingenew, which is 280 miles by rail north of Perth*.

(*b*) Eyeregulla Springs*.

(*c*) Mingenew Spring*.

(*d*) Moriary Spring, 8.5 miles south-east of Mingenew*.

8. DESCRIPTIONS OF DIATOMITES EXAMINED FROM VARIOUS LOCALITIES.

Descriptions are given only of those diatomites which have been examined microscopically and which are indicated by the sign "*" in the foregoing section. The remarks on the diatom assemblages in the diatomites refer to the mount of the samples on the micro-slides only but these may be taken as representative of the deposit. Short notes on the main features of the deposits are also given but more complete descriptions are available in the Summary Report on Diatomite (Crespin, 1946). All the diatomites examined are of fresh-water origin.

A.—QUEENSLAND.

The cylindrical diatom *Melosira* is the dominant form in all the diatomites examined from this State, except that from Innot Hot Springs. All deposits but one are associated with Tertiary basalts. The Innot Hot Springs occurrence is Recent to Sub-Recent in age. The only production of diatomite in Queensland in the last ten years has come from the deposit at Black Duck, the maximum amount of 144 tons being mined in 1944.

(i) Innot Hot Springs.

The deposit is small, the diameter being about 1,000 feet and the thickness about three feet. The diatomite, which is of fairly good grade for filtration purposes, is grey in colour and contains a small quantity of impure material and a large percentage of minute broken frustules of diatoms. Unbroken frustules are abundant and well preserved. (Plate 4, Fig. 1.)

The diatom assemblage is different from that in other Queensland diatomites. The most prominent genera are the rod-like *Epithema* and the broad rectangular-shaped *Diatomella*. *Epithema* is represented by single and complete valved specimens. The length of the frustule varies from 45 to 130 microns and the greatest width of a complete specimen is 25 microns. The broad rectangular *Diatomella* measures from 10 to 22 microns in length and 10 microns in width. The narrow rectangular *Diatoma* is 22 microns in length. Frustules of the filiform genus *Synedra* range from 25 to 300 microns in length. The naviculoid genera, *Navicula* and *Cymbella*, are present but are not common. Frustules of the former range in length from 45 to 50 microns and have a width of 20 microns; the latter has a length ranging from 45 to 70 microns. Other genera noted include *Amphora*, frustules measuring from 45 to 90 microns in length and 20 microns in width; *Pinnularia* represented by many broken frustules, the only complete specimen present in the slide measuring 110 microns in length; the stout ovate *Diploneis*, 20 microns long and 45 microns wide; *Nitzschia*, *Surrirella* and *Rhopalodia*.

Sponge spicules are fairly common in the sample examined; one thick variety measures from 90 to 400 microns in length.

(ii) Cunjeboy.

The thickness of the diatomite at this locality ranges from a few inches to several feet. The diatomite, which is creamy white in colour, is of fairly good grade although clay particles are common. The chief component diatom is *Melosira*, the average length of the specimens being 10 microns, with a width of 8 microns. Other genera include broken frustules of *Synedra*, measuring from 140 to 240 microns in length and 14 microns in width; *Pinnularia*, fragments of frustules having a maximum width of 22 microns, and *Navicula*, which is rare in the sample, with a length of 44 microns.

A few sponge spicules measuring up to 180 microns in length are present.

(iii) Planet Downs.

No details of the field occurrence of the diatomite at Planet Downs are available. The diatomite, which is of a moderately good grade, is chalky white in colour. It is composed chiefly of fine cylinders of *Melosira*. Other genera of diatoms noted are few and include *Stauroneis*, measuring 90 microns in length, a short stout form of *Pinnularia*, 80 microns in length, and frustules of *Navicula* and *Eunotia*.

(iv) Junee.

The main deposit of diatomite at this locality is 30 feet thick and has been traced for at least 900 feet (Reid, 1939). Some beds of clay are intercalated with the diatomite, which is white in colour and of good grade. It is composed almost entirely of the diatom *Melosira*. The only other diatom noted is *Synedra*, which is rare. A few broken sponge spicules are also present.

(v) Black Duck.

This deposit of diatomite is the only one in Queensland which is being developed on a commercial scale, (Ball, 1927). Diatomite has been exposed and exploited over a length of more than a mile and it has a probable width of a quarter of a mile. In most places the clean diatomite is at least 7 feet thick and in some cases a thickness of more than 10 feet has been proved. It is overlain and underlain by basalt. The diatomite is whitish in colour and of good grade. It is composed almost entirely of *Melosira*, with a few frustules of *Navicula*. Sponge spicules are rare.

(vi) Tabletop, near Canungra.

No information is available about this deposit. The diatomite, which is of medium grade, is dark cream coloured and laminated. Clay particles are common. *Melosira* is abundant and broken sponge spicules numerous.

(vii) Numinbah.

The diatomite at this locality is hard and dense, and is poor in grade. Diatoms are not common, *Melosira* being the only form identified. Fragments of sponge spicules are present.

B.—NEW SOUTH WALES.

The diatomites in this State, like most of those in Queensland, are composed almost entirely of the small cylindrical diatom *Melosira*. All deposits are Tertiary in age and are associated with volcanic rocks. Most of them have been or are being worked commercially. The largest annual production was in 1941 when 4,852 tons of diatomite were mined, of which 2,573 tons came from the Coonabarabran district.

(i) Lismore-Ballina District.

The deposits of diatomite in this district are situated at Tintenbar and Wyrallah.

(*a*) *Tintenbar*.—Little is known of this deposit but it is reported that the diatomite is associated with cherty rock and opal in a bed 1 to 4 feet thick between basalt flows. The diatomite, which varies considerably in grade, is white in colour and somewhat clayey. It contains numerous diatoms, the principal form being *Melosira*. The majority of diatoms are broken.

(*b*) *Wyrallah*.—The deposits here are scattered on both sides of the Richmond River (Card and Dun, 1897). They are overlain by scoriaceous basalt and occur in depressions in the same rock. One deposit merges downwards into a band of yellowish opal about 1 foot thick. The diatomite is cream coloured and of medium grade. *Melosira* is very abundant; other genera include *Cymbella, Cocconeis, Gomphonema, Pinnularia* and *Navicula.* A few sponge spicules have been noted.

(ii) Barraba District.

The main deposits of diatomite in this district are at Bell's Mountain and in the Nandewar Ranges.

(*a*) *Bell's Mountain.*—The diatomite at this locality is overlain by Tertiary basalt, which forms the top of Bell's Mountain, and is underlain by sandstones and shales of Devonian age (Raggatt, 1928). Exposures suggest a total thickness of at least 36 feet, consisting of bands of good white diatomite and of impure iron-stained diatomite, with narrow intercalated bands of sandstone and clay. The good grade diatomite is chalky white in colour and is composed almost entirely of *Melosira.* (Plate 3, Fig. 4.)

(b) *Nandewar Ranges.*—The principal deposit of diatomite is about 9 feet thick, and is associated with and overlain by volcanic tuff, which in turn is overlain by basalt. (Raggatt, 1928). The diatomite is cream coloured, and in places contains segregations of sponge spicules. The material from these segregations consists almost wholly of fine spicules measuring up to 120 microns in length, with the majority averaging about 60 microns. A few frustules of the diatom *Melosira* are present. The chalky diatomite is composed almost entirely of *Melosira,* many coarse frustules measuring up to 15 microns in length and the fine ones up to 20 microns. A few sponge spicules are present.

(iii) Coonabarabran District.

Diatomite occurs at three localities in this district, but only the material from the main deposit at Chalk Mountain has been examined.

(*a*) *Chalk Mountain.*—Diatomite occurs at the top of the mountain at a height of about 2,000 feet above sea level, and is overlain by basalt (Raggatt, 1928). The deposit covers approximately 20 acres and ranges in thickness from 10 to 25 feet. The diatomite is buff coloured and fairly dense. It is composed almost entirely of *Melosira, and* two varieties of the species *M. granulata* have been recognized. A long thin variety measuring 20 microns in length and 4 microns in width is very common; a stouter and shorter variety has a length of 12 microns and a width of 10 microns. Other diatoms are scarce in the sample examined. A frustule of *Neidium* measuring 60 microns in length was noted. Frustules of *Synedra* range from 60 to 80 microns in length. Small sponge spicules average about 80 microns in length.

(iv) Bunyan.

Diatomite at this locality near Cooma has been proved over a length of 900 feet and a width of 300 feet (Raggatt, 1928). The main quarry shows a thickness of diatomite ranging up to 12 feet without exposing the bottom of the bed. The diatomite, which is of good grade, is whitish in colour and is composed almost entirely of *Melosira.* (Plate 3, Fig. 2.)

(v) Cudal.

The diatomite at this locality near Orange is overlain and underlain by basalt (Raggatt, 1928). It has a thickness of 20 feet and has been proved by workings for 800 feet along the outcrop and probably extends a considerable distance farther. The diatomite is cream coloured and of good grade. *Melosira* is the predominant diatom. A frustule 60 microns long of the filiform *Synedra*, which is rare, was observed. A few specimens of *Eunotia, Cymbella, Pinnularia* and *Gomphonema* are also present. Sponge spicules are rare, one specimen measuring 120 microns.

(vi) Merriwa.

No details are available about this deposit of diatomite. The rock is cream coloured and consists almost entirely of fine cylinders of *Melosira*. Frustules of the short, stout form of other deposits are rare. Sponge spicules are scarce.

C.—VICTORIA.

The chief occurrences of diatomite in this State are at Lillicur near Talbot, Newham near Woodend, Moranding near Kilmore and Happy Valley near Linton. The diatom content differs from those of Queensland and New South Wales, and at the same time the diatom assemblage varies in different deposits. All deposits but one, that at South Yarra near Melbourne, are associated with the Newer Basalt and are Tertiary in age. Mahony (1912) described many of the deposits. In 1944, 1,128 tons of diatomite were produced in Victoria, the highest production (550 tons) coming from Newham.

(i) Loddon District.

The only diatomites examined from this district are from Lillicur and Talbot.

(*a*) *Lillicur*.—This deposit of diatomite is the oldest to be worked in Victoria. It was originally described by Krause in 1886 and production has been almost continuous since that date. (Plate 2, Fig. 2.)

Two deposits have been worked in recent years. One deposit, which is overlain by basalt, consists of 3 to 5 feet of diatomite, laid down in a trough-like depression in weathered vesicular basalt and overlain by an average of 4 feet of clay and basaltic soil. Diatomite has been proved over a total length of 700 feet with a total width of approximately 200 feet. The second deposit varies considerably in thickness up to a maximum of about 5 feet.

The diatomite is snow white in colour, very light and porous, and contains about 5 per cent. of clay. It has proved a satisfactory filter medium, as it contains an assemblage of diatoms which is regarded as necessary in a fresh-water diatomite for such a purpose. The commonest diatom is the long needle-shaped *Synedra* but the naviculoid forms such as *Navicula* and *Cymbella*, the long ovate *Pinnularia* and *Amphora*, the stout ovate *Cocconeis* and the rod-like *Eunotia*, are well represented. The ratio of the filiform frustules to the others is about 50 per cent. The long needle-shaped *Synedra* also occurs in abundance with other diatoms of various shapes and sizes at Moranding and Happy Valley, near Linton. The diatomite from both of these localities is used as a filter medium, but the purity of the Lillicur material gives it superior filtering qualities. The absence of the honeycomb shaped diatoms of the marine deposits in California prevents the Lillicur diatomite from being a high class filter medium.

The genus *Synedra* is represented by two varieties, a stout form averaging 240 microns in length and with a width of 10 microns, and a thin one which also measures 240 microns in length but which is only 4 microns in width. Broken frustules of the genus range from 50 to 200 microns in length. A small species of *Navicula*, with a length of 16 to 20 microns and a width of 4 microns, is very common. Frustules of *Cymbella* are fairly common, and measure from 40 to 50 microns in length and 15 microns in width. *Cocconeis* is abundant; this small ovate diatom measures from 20 to 40 microns in length and 10 to 16 microns in width. Other genera include *Pinnularia*, from 100 to 150 microns long and 20 microns wide; *Stauroneis*, 130 microns in length and 20 microns in width; *Gomphonema* from 24 to 50 microns in length; *Nitzschia, Melosira, Eunotia* and *Amphora.* Sponge spicules are scarce.

(*b*) *Talbot.*—Diatomite occurs over an area of about one square mile around the township of Talbot, near Lillicur (Mahony, 1912). It is a whitish, chalky rock, composed of an assemblage of diatoms which includes some genera that are common in the Lillicur material and others in the diatomite at Mickleham. Frustules of *Synedra*, measuring up to 200 microns in length, are not as common as at Lillicur. *Cocconeis* and *Tabellaria* are fairly numerous. Other diatoms include *Pinnularia* measuring up to 160 microns in length, *Cymbella, Diatoma, Fragilaria, Gomphonema, Neidium* and *Melosira.*

(ii) Moranding.

Diatomite outcrops on the western flank of a basalt-covered ridge (Thomas, 1937). It was deposited on an irregular surface of weathered vesicular basalt and was later overridden by a basalt flow of at least 25 feet in thickness. Diatomite has been proved over an area of 350 feet long and 250 feet wide. The thickness of the deposit ranges from 8 to 17 feet with an average of 10 feet. The diatomite, which is white in colour, is used as a filter medium.

The diatom assemblage is similar to that present in the diatomite at Lillicur. *Synedra* frustules form at least 50 per cent. of the diatoms present. Other genera which are common are *Eunotia, Navicula, Gomphonema* and *Cocconeis.* Rarer forms are *Pinnularia, Cymbella* and *Stauroneis.* Both crude and milled materials have been examined. (Plate 2, Fig. 1.)

In the crude diatomite the diatoms noted include *Synedra*, a thin variety measuring 500 microns in length and 2 microns in width, and a stout one, 200 to 300 microns in length and 10 microns in width; *Eunotia*, with a length ranging from 50 to 80 microns; *Gomphonema*, from 40 to 50 microns in length; *Pinnularia*, 140 microns; *Stauroneis*, 150 microns; *Navicula*, 20 to 30 microns; and *Cocconeis*, 20 to 30 microns in length and 15 microns in width.

In the milled material, no complete frustules of *Synedra* are present, the broken specimens measuring from 20 to 120 microns in length, with a few of 200 microns. Other diatoms are unbroken.

(iii) Newham.

Beds of diatomite are found at Newham at several horizons in sediments of various kinds, which were deposited in a large basin-like depression (Howitt, 1936). The sediments with which the diatomite is associated are about 30 feet thick and are covered with basalt. The principal deposit is exposed in extensive workings underground, and consists of two seams separated by approximately 4 feet of sandy clay. The top seam, which produces the better grade diatomite, averages 6 feet in thickness.

The diatomite at Newham is the only deposit in Victoria in which the diatom *Melosira*, so prominent in the diatomites of Queensland and New South Wales, is common. Associated with *Melosira* are *Synedra, Gomphonema, Cymbella, Eunotia* and *Cocconeis*. (Plate 3, Fig. 3.)

Two samples of diatomite have been examined. One is cream to buff coloured, and contains numerous frustules of the cylindrical diatom *Melosira*, measuring 10 microns in length and 10 microns in width. However, this form is not as abundant as in the diatomites of the other eastern States. The majority of the larger diatoms are broken. Several incomplete frustules of the filiform *Synedra* are present, but only one complete *Pinnularia*, measuring 130 microns in length, has been noted. Numerous small diatoms are recorded, including *Gomphonema*, which is fairly common and measures from 40 to 60 microns in length; *Cymbella*, with a length of 40 microns; *Eunotia*, 25 microns; *Neidium*, 40 microns; *Cocconeis*, which is common, from 20 to 25 microns in length and from 14 to 20 microns in width; and *Stauroneis*. Sponge spicules measure up to 120 microns in length.

The other sample is chalky white and finely laminated. Most of the diatoms are small and broken, and are similar to those recorded from the first sample. *Melosira* is more abundant than in the cream coloured diatomite, while *Cocconeis* is rare. Other diatoms noted are *Synedra*, broken frustules measuring from 40 to 160 microns in length; *Eunotia*, 60 microns; *Cymbella*, 70 microns; and *Navicula*, which is rare, 22 microns.

(iv) Happy Valley near Linton.

The deposit consists of a gently dipping seam of diatomite in a depression in weathered, vesicular basalt. It is overlain by about 4 feet of clay and by a later flow of basalt which has been almost entirely removed. The limits of the deposit have not been proved, but the diatomite averages about 5 to 6 feet in thickness. Much of the material is ironstained. The better grade diatomite is white in colour and is finely bedded. (Plate 2, Fig. 3.)

The diatom assemblage consists of forms of various shapes and sizes, the smaller ones predominating. The needle-like *Synedra* is common and is represented by two varieties, a stout one measuring from 60 to 470 microns in length and 10 microns in width and a thin one, 400 microns in length and 4 microns in width. Frustules of the long ovate *Pinnularia* have a length of 80 microns. Small diatoms include *Fragilaria*, from 10 to 20 microns in width, *Tabellaria*, 20 microns in length, *Cocconeis*, 25 to 40 microns in length and 10 to 15 microns in width; *Gomphonema*, from 20 to 40 microns in length; *Cymbella*, 50 microns in length; and *Melosira*, with a length and width of 20 microns.

(v) Mickleham.

Little is known of this deposit, but it is understood that it is not large (Dunn, 1917). The diatomite occurs beneath a basalt outlier. It is creamy white in colour and flaky in texture. The number of sponge spicules present preclude it from being of any commercial value as a diatomite. In the sample examined, at least 30 per cent. of the forms is made up of sponge spicules. The remaining 70 per cent. comprises small cylindrical and ovate diatoms, with some broken frustules of the needle-like *Synedra*. *Melosira* and *Fragilaria* are common; the former measures from 10 to 20 microns in length and 10 microns in width, and the latter ranges from 12 to 20 microns in length. Other diatoms include the same two varieties of *Synedra* as have been recognized at Lillicur, Moranding and Happy Valley; *Cocconeis*, with a length of 30 microns and width of 20 microns; *Tabellaria*, 20 microns in length; *Gomphonema*, which ranges from 50 to 80 microns in length; *Pinnularia*, 120 microns in length; and *Navicula*. Both prickly and smooth varieties of sponge spicules are present, the majority of specimens being about 20 microns in length.

(vi) Portland District.

(*a*) *Allestrie.*—This deposit of diatomite is about half an acre in extent and occurs in almost flat basaltic country (Kitson, 1906). The diatomite, which is of good quality, is chalky white and is rich in rod-like and ovate shaped diatoms. *Cocconeis* and *Gomphonema* are very common. Frustules of the former range from 20 to 40 microns in length and from 10 to 20 microns in width; and of the latter from 40 to 80 microns in length. Broken frustules of *Synedra* are common in the sample and are from 30 to 130 microns in length, with a width of 10 microns. Other diatoms include *Pinnularia*, measuring from 90 to 140 microns in length; *Eunotia*, from 40 to 60 microns in length; *Cymbella*, which is fairly common, up to 60 microns in length; *Navicula*, which is rare, 25 microns in length and 10 microns in width; and *Melosira*, with a length of 10 to 15 microns and width of 10 microns.

(vii) Melbourne Suburbs.

(*a*) *South Yarra.*—The diatomite from South Yarra was originally described by Dr. J. Coates in 1860, and at that time this part of Melbourne was a swamp (Mahony, 1912). The diatomite was apparently interbedded with muds and clays "in which there were plentiful remains of marine organisms" and is Recent to Sub-Recent in age. A small sample of diatomite described by Kitson (1902) from a locality about a quarter of a mile away from the original one was given to the author by the late Mr. F. Chapman. The following genera have been recognized:—*Nitzschia, Navicula, Epithema, Neidium, Diatoma, Cymbella, Pinnularia* and *Cyclotella*. This assemblage of diatoms is similar to that found in the diatomites associated with lakes and swamps elsewhere in Australia.

D.—TASMANIA.

No deposits of diatomite of commercial importance are known in this State. The only recorded occurrences are in the Midlands.

(i) Locality 4 miles East of Andover.

Diatomite occurs here in a shallow depression on a surface of Mesozoic dolerite, (Nye, 1921), and is probably of Upper Tertiary age. The diatomite, which is of medium grade, is buff coloured, with darker bands.

Melosira is the predominant diatom in the sample and three varieties of the species *M. granulata* are recognized. One is 10 microns in length and from 20 to 30 microns in width; the second, 10 microns in length with a similar width; and a third a large form with a width of 80 microns. Other genera are not common. *Synedra* is represented by a few small fragments; *Cymbella* by a large species measuring 60 microns in length; *Pinnularia* by frustules ranging from 80 to 130 microns in length; and *Eunotia*. A few sponge spicules are present.

(ii) Rushy Lagoon, "Fonthill", Andover.

The material examined is black soil, collected from various portions of the Lagoon. It contains numerous sponge spicules, most of which are broken. Complete specimens measure up to 200 microns in length. Diatoms are not common, the following genera being represented—*Melosira, Cymbella, Pinnularia, Gomphonema, Navicula* and *Fragilaria.*

(iii) Bishopsbourne, near Longford.

No information is available concerning this deposit. The sample examined is a grey coloured diatomite containing abundant well preserved diatoms, and it is apparently similar in age to the sample from near Andover. *Melosira* is common. Other forms in varying abundance are *Synedra, Cymbella, Navicula, Neidium, Gomphonema, Tabellaria, Eunotia,* and *Stauroneis.* (Plate 3, Fig. 1.)

E.—SOUTH AUSTRALIA.

The only record of diatomite in this State is from Eight Mile Creek Swamp, south of Mount Gambier. No field data are available concerning the deposit, but it is Recent to Sub-Recent in age. The assemblage of diatoms is similar to that comprising the diatomite at Lillicur, Victoria, which is of Tertiary age. The commonest genera are *Synedra, Navicula, Mastogloia* and *Cymbella.* A few frustules of the broad ovate genus *Cocconeis* are also present.

F.—WESTERN AUSTRALIA.

Occurrences of diatomite are numerous in this State. All the deposits are Recent to Sub-Recent in age and are associated with swamps and lakes, soaks and springs. The diatom assemblage is different from that in the majority of deposits in the eastern States, but is similar to that in the diatomite from Innot Hot Springs, Queensland. The only deposit to be worked commercially is at Lake Gnangarra in the Waneroo District, and the only recorded production is 40 tons in 1943.

(i) Cape Riche.

No information is available regarding the field occurrence of this diatomite. The material which is of medium grade is grey in colour. It contains well preserved delicate diatoms, *Neidium* and *Eunotia* being the commonest genera. Frustules of the former measure from 30 to

80 microns in length and 10 microns in width, and those of the latter range from 40 to 70 microns in length. *Pinnularia* is represented by a small stout species, measuring up to 140 microns in length. Other genera include *Diploneis, Cocconeis, Frustula* and *Amphora,* frustules of this form measuring from 60 to 100 microns in length and 35 microns in width.

(ii) Seven Miles North of Whaling Station, Cheyne Beach.

No field data are available about this deposit of diatomite. The material is of a good grade and is grey in colour. It contains well preserved diatoms which exhibit considerable variety in shape and size, about 30 per cent. of them being naviculoid in shape. The naviculoid forms include *Navicula* measuring 20 microns in length and 10 microns in width; *Cymbella,* with a length of 80 microns and width of 10 microns; and *Neidium,* measuring from 60 to 100 microns in length and 10 microns in width. Amongst the remaining 70 per cent. of diatoms are a long and thin *Gomphonema,* 60 to 100 microns in length; long ovate *Pinnularia* from 80 to 100 microns in length, and *Amphora* from 50 to 100 microns in length and 30 microns in width; stout, ovate *Cocconeis* and *Diploneis,* each measuring 40 microns in length and 20 microns in width; rod-like *Eunotia* with a length of 90 microns and *Epithema,* 90 microns; and many broken frustules of the filiform *Synedra,* ranging in length from 60 to 240 microns, and *Nitzschia,* 70 microns. Some fine sponge spicules are present.

(iii) Albany District.

Diatomite occurs at several localities in this district, but little is known of the deposits, all of which are apparently associated with swamps.

(*a*) *Grassmere.*—No details are available concerning this deposit near Albany. The majority of diatoms consist of the rod-like *Eunotia* and the long, ovate *Pinnularia* and *Amphora,* with a lesser number of small naviculoid forms as *Navicula, Cymbella* and *Stauroneis.* Frustules of *Eunotia* measure from 60 to 70 microns in length. One species of *Pinnularia* is 210 microns long, a second species, represented by a stout form, measures from 80 to 120 microns in length and 20 microns in width. Frustules of *Amphora* are 50 microns in length. Two coarsely ornamented species of *Navicula* measure 40 and 60 microns in length respectively. Other naviculoid forms are *Cymbella,* measuring 60 microns in length, *Neidium* and *Stauroneis,* both 80 microns long. Other diatoms include *Diploneis* with a length of 40 microns and a width of 20 microns; *Gomphonema,* ranging from 60 to 70 microns in length; broken frustules of *Synedra,* 50 microns in length; and the disc-shaped *Cyclotella,* measuring from 40 to 50 microns in width. Sponge spicules comprise about 30 per cent. of the forms present, the length of the spicules ranging from 30 to 200 microns.

(*b*) *Ewart's Swamp, Grassmere.*—The diatomite occurs in an 18-in.-24-in. layer in the swamp. It is grey in colour and the sample examined is rich in diatoms. Rod-like and stout ovate forms constitute about 70 per cent. of the diatoms present, the remainder being naviculoid in shape. Frustules of *Eunotia* are moderately common, and measure 70 to 90 microns in length, and those of *Epithema,* 70 microns.

Diploneis, with a length of 40 microns and width of 20 microns, is common. Frustules of *Pinnularia* are chiefly broken but a complete specimen measures 180 microns in length. Other diatoms include two species of *Navicula,* one from 40 to 60 microns in length and 12 microns in width, and the other 25 microns by 10 microns; *Cymbella* measures 60 microns in length and 16 microns in width; *Amphora* 70 microns in length; *Diatoma* 60 microns long and 10 microns in width; *Gomphonema* and *Cocconeis.* (Plate 5, Figs. 1-3.)

(*c*) *A. E. Hardie's Property, Jakama Creek.*—The diatomite is poor in grade. It contains many impurities and diatoms are not very common. The genera recognized include the disc-like *Cyclotella*; *Pinnularia,* measuring 100 microns in length; two species of *Navicula* both having a length of 40 microns; *Cymbella,* measuring 50 microns in length and *Stauroneis.* Prickly and smooth varieties of sponge spicules ranging in length from 90 to 200 microns, are numerous.

(*d*) *T. Hawley's Property, Millbrook.*—The diatomite is grey in colour and rich in diatoms, but the majority of frustules are broken. The forms include *Gomphonema, Navicula, Melosira, Stauroneis, Eunotia, Pinnularia* and *Diploneis.* A few sponge spicules are present.

(iv) Fremantle District.

Diatomite occurs in several swamps in this district, but little is known of the deposits.

(*a*) *Spectacles Swamp.*—The diatomite is poor in quality. Diatoms are not common and many of the frustules are broken. A complete frustule of *Pinnularia* measures 160 microns in length and frustules of *Amphora* are 90 microns in length. *Navicula* is also present. There are a few broken sponge spicules.

(v) Herdsman's Lake, North of Perth.

This diatomite contains a considerable amount of organic material, but only a few diatoms. Genera noted are *Pinnularia, Cocconeis* and *Gomphonema.* Sponge spicules are common.

(vi) Waneroo District.

Diatomite deposits are numerous in this district, the only one of commercial importance being at Lake Gnangarra, (Simpson, 1903, 1904).

(*a*) *Lake Gnangarra.*—Diatomite occurs around the northern and western shores of Lake Gnangarra, which is a permanent freshwater lake east of Waneroo. The area of the deposit is about 15 acres, with an average thickness of 5 feet. The diatomite is saturated with water and when dried has a dark grey colour. It consists of a felted mass of fine sponge spicules, together with numerous diatoms. (Plate 5, Fig. 4.)

The commonest diatoms are *Pinnularia, Eunotia, Neidium, Frustula* and *Amphora.* Two species of *Pinnularia* are present, a large form measuring from 180 to 200 microns in length and 20 to 30 microns in width and a small one, 70 to 90 microns in length and 15 microns in width. Frustules of *Eunotia* range in length from 40 to 90 microns; of *Neidium* from 50 to 90 microns in length and 10 to 15 microns in width; and of *Amphora* from 60 to 80 microns in length and from 10 to 40 microns in width. Other forms include *Navicula*, 20 microns long and 10 microns wide; *Melosira*, measuring 10 microns both in length and width; *Cymbella, Stauroneis, Nitzschia* and *Synedra*. Sponge spicules are represented by coarse specimens measuring from 140 microns in length and masses of fine ones chiefly about 40 microns.

(*b*) *Little Badgerup Swamp*.—The diatomite, which is about 16 acres in extent, has been proved to a depth of 5 feet in the centre of the swamp. It is understood that it is of good quality. Diatoms are numerous. Large frustules of *Pinnularia* are very common, measuring from 140 to 240 microns in length and 30 microns in width. A species of *Amphora*, measuring from 50 to 70 microns in length and 30 microns in width, is equally abundant. Naviculoid forms include *Navicula, Cymbella* and *Stauroneis*. Sponge spicules are from 70 to 240 microns long.

(*c*) *Lake Badgerup Swamp*.—The diatomite is of inferior quality. It contains few diatoms, all frustules being broken. The forms noted include *Pinnularia, Amphora* and *Eunotia*. Sponge spicules are also present.

(*d*) *Lake Jundabup*.—The lake is about 700 acres in extent and is completely filled with diatomite, which is at least 6 feet in thickness at only a short distance from the shore. The diatomite contains many impurities and numerous broken sponge spicules. The diatoms include *Pinnularia*, one frustule measuring 200 microns in length; *Navicula*, 20 to 40 microns in length and 20 microns in width; *Eunotia*, 25 to 90 microns in length; and *Stauroneis*, 64 microns in length.

(*e*) *Lake Mariginiup*.—The lake is completely filled with diatomite, the specimen examined coming from the centre of the lake. The diatomite is poor in quality and the diatoms are mainly broken. The forms noted are *Navicula*, measuring from 40 to 50 microns in length and 20 microns in width, *Eunotia, Cymbella, Diploneis* and *Amphora*.

(*f*) *Chinaman's Swamp*.—The sample of diatomite examined was collected 1 foot from the surface. Sponge spicules comprise about 80 per cent. of the forms present, fine specimens averaging about 30 microns in length and coarse ones 140 microns. The diatoms include *Pinnularia, Amphora, Eunotia* and *Neidium*.

(vii) Swamp on P. Vesty's Property, Bullsbrook.

The diatomite from this locality is of poor grade and the diatoms present are very broken. The forms noted include *Pinnularia, Amphora, Eunotia* and *Neidium*.

(viii) Mingenew District.

The diatomite deposits in this district are all associated with springs.

(*a*) *Arrowsmith River, Arrino*.—The diatomite from this locality is rich in diatoms, but at least 50 per cent. of the forms are broken. The diatoms include *Epithema*, measuring up to 150 microns in length, *Pinnularia*, 100 microns, *Diploneis* (common but usually broken, complete specimens measuring 40 microns in length and 20 microns in width), *Navicula, Cymbella, Neidium, Stauroneis* and *Melosira* (rare).

(*b*) *Eyeregulla Springs.*—The diatomite contains numerous fine quartz grains and many sponge spicules which measure from 130 to 140 microns in length. Diatoms are common, but many frustules are broken. Forms noted are *Pinnularia,* one unbroken frustule measuring 140 microns in length; *Epithema,* 60 microns in length; *Neidium,* 20 in length, *Eunotia* and *Diploneis.* The main deposit is about 5 feet thick.

(*c*) *Mingenew Spring.*—The diatomite contains much organic material. Diatoms are common, the long ovate and rod-like genera being well represented. Genera include *Epithema, Eunotia, Amphora, Pinnularia* and *Nitzschia.*

(*d*) *Moriary Spring.*—This diatomite is of a poor grade. Diatoms are scarce, and *Amphora, Pinnularia* and *Epithema* are the only forms recognized. Sponge spicules are also present.

9. POSSIBLE ECONOMIC VALUE OF SPECIMENS EXAMINED.

The annual consumption of diatomite in Australia for the year 1944 was approximately 4,000 tons and in 1945, 3,600 tons. Of this, 1,289 tons were imported in 1944 and only 750 tons in 1945. In 1942, however, 3,041 tons were brought in from California. The small tonnages for 1944 and 1945 were due primarily to the shortage of shipping space as the area occupied by each ton of diatomite is 75 cubic feet. Most of the domestic production, which amounted to 3,605 tons in 1944, is used for purposes other than filtration, e.g., insulation, fillers, absorbents, carriers, mild abrasives and catalysts. Practically the whole of the imported product is consumed as a filter medium. The reason for the present survey, which was undertaken during the war, was the necessity for finding a diatomite in Australia suitable for filtration purposes to replace imports as far as possible for that period.

Prior to the introduction to the market of Californian diatomite, which is composed of rounded, honeycomb and needle-like diatoms, it was considered in Great Britain that the long boat-shaped or spindle-like forms were the most efficient for filtration purposes, and it has been proved that, provided a sufficient amount of diatomite is used to afford the minimum absorbing surface required for the colloids present, satisfactory results can be obtained with diatomites that vary considerably in physical properties. Later investigations showed that a mixed assemblage of long, thin, needle-like and rounded honeycomb-shaped diatoms with the needle-like forms predominating was preferable (Eardley-Wilmot, 1928). More recently (Skinner, &c., 1944), it has been proved that not only the shape and size of the diatoms is important, but also the distribution of the particle size and the process treatment of the diatomite.

The diatomite filter aids marketed by the Celite Company and the Dicalite Company of California are the results of special treatment (Mulyran, 1938), whereas a large proportion of the Australian production is marketed in crude form. It is recognized that the *Melosira* type of diatomite will not give a filter aid equal in properties to the imported Californian article, but for some filtration uses it may be found economical to use larger quantities of the relatively cheap New South Wales and Queensland diatomite in place of the dearer, highly refined imported product. There seems no reason why the Victorian, and possibly some of the Western Australian, diatomite could not be successfully substituted for the Californian material, if available in sufficient quantities and if due regard is paid to selective mining.

Diatomites in which small diatoms of similar shape and size predominate have been regarded as inferior for use as filter media. It is for this reason that the *Melosira* diatomites, which are so prominent in Queensland and New South Wales, have been considered unsuitable for this purpose. It is known, however, that, by special treatment, some users have been able to make satisfactory use of the *Melosira* type of diatomite for filtration. For instance, Davis Gelatine (Australia) Proprietary Limited has been successful in treating a local product of this type, to the extent that it now almost wholly replaces the imported one in their operations.

Calcination in some cases improves the filtration properties of diatomite. This treatment removes the water and small quantities of other impurities which are present in most diatomites. During the process of calcination, carbonaceous matter is entirely removed at a dark red heat, between 500 and 600 degrees centigrade. The most convenient temperature for calcination is a full red heat of about 800 degrees centigrade. It is important that the temperature should not be high enough to destroy the structure of the diatoms or to fuse any of the remaining impurities. Calcination will not remove such impurities as iron, alumina, lime, magnesia and alkalis. When quantities of 1.15 per cent. or more of iron oxide are present the calcined material becomes pink. This condition can be prevented by adding a small amount of soda, magnesia or common salt to the crude diatomite, the result being a pure white product after calcining. It has been proved that by the addition of salt to *Melosira*-rich diatomites, such as occur at Quesnel in Canada and in New South Wales and Queensland, a product suitable for sugar filtration can be produced (Eardley-Wilmot, 1928).

In Victoria, the assemblage of diatoms in the diatomites varies from deposit to deposit, and for the most part, few impurities are present. The diatomites at Lillicur and Moranding contain diatoms which are suitable as filter media. The assemblage is dominated by the filiform genus *Synedra*, which is associated with stout ovate and naviculoid forms. The diatomite is produced at these two localities primarily for filtration. The Colonial Sugar Refining Company Limited has used the Lillicur material successfully in its filtering operations, and another Australian company operating in Victoria reports that it has already produced a grade of treated diatomite as a filter medium, which it considers compares favorably in efficiency with the imported material.

The diatomites at Newham near Woodend, Happy Valley near Linton, and at Portland contain abundant small diatoms of varying shapes and sizes. Blending of material from any of these deposits with the needle-like *Synedra* diatomites of Lillicur and Moranding should give a product with good filtering properties.

It is understood that the deposit at Mickleham is worked out. However, the material contained diatoms suitable for filtration purposes, but the abundance of large sponge spicules would possibly have limited its usefulness in that direction.

In Tasmania, neither of the diatomites from Andover are suitable as filter media, but that from near Longford shows a suitable admixture of forms of diatoms for that purpose.

In South Australia, the diatomite at Eight Mile Creek contains an assemblage of diatoms similar to that present at Lillicur and Moranding and, therefore, may be suitable for filtration.

The diatomites of Western Australia vary from poor to good in their filtering qualities. Even those which have possibilities would require considerable preliminary treatment on account of the impurities present.

Possibly the diatomite possessing the most suitable qualities for filtering purposes is that from Lake Gnangarra, Waneroo district. The diatoms include long ovate and naviculoid forms, together with a felted mass of fine sponge spicules.

Other diatomites which may prove of commercial value for filtration purposes occur 7 miles north of the whaling station at Cheyne Beach and at Cape Riche, where an assemblage of very well preserved and suitable diatoms is present.

Certain of the diatomites at Grassmere, 6 miles west of Albany, after some preliminary treatment could be used for filtration. Here long ovate diatoms are associated with numerous rod-like and naviculoid forms and an occasional frustule of the disc-like *Cyclotella*.

At Chinaman's Swamp in the Waneroo district, the diatomite contains a large percentage of fine sponge spicules averaging 30 microns in length. These together with the diatoms present may make this material suitable for filtering purposes.

The diatomite in the bed of the Arrowsmith River, near Arrino, is very rich in diatoms suitable for filtration, but the percentage of broken forms would detract from its value.

The diatomite at Mingenew Spring, although it contains abundant diatoms suitable for filtering uses, would require considerable preliminary treatment on account of impurities present.

10. ACKNOWLEDGMENTS.

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PLATE 1.

Fig. 1.—*Rhopalodia ventricosa.* Lillicur, Victoria. X715.
Fig. 2.—*Neidium iridus.* Bed of Arrowsmith River, Arrino, W.A. X715.
Fig. 3.—*Amphora robusta.* Little Badgerup, Waneroo District, W.A. X715.
Fig. 4.—*Gomphonema intricatum.* Lillicur, Victoria. X1270.
Fig. 5.—*Stauroneis phonenicentron.* Lillicur, Victoria. X715.
Fig. 6.—*Fragilaria harrisoni.* Mickleham, Victoria. X1270.
Fig. 7.—*Eunotia major.* Lillicur, Victoria. X435.
Fig. 8.—*Nitzschia sp.* Little Badgerup, Waneroo District, W.A. X435.
Fig. 9.—*Hantzschia sp.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X715.
Fig. 10.—*Melosira granulata.* Chalk Mountain, Bugaldi, N.S.W. X1270.
Fig. 11.—*Gomphonema acuminatum* var. *coronatum.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X715.
Fig. 12.—*Navicula maculata.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X1270.
Fig. 13.—*Navicula cuspidaria* var. *ambigua.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X715.
Fig. 14.—*Cocconeis placentula.* Lillicur, Victoria. X640.
Fig. 15.—*Epithema turgida.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X435.
Fig. 16.—*Cymbella ventricosa.* P. Vesty's property, Bullsbrook, W.A. X435.
Fig. 17.—*Synedra ulna.* Lillicur, Victoria. X410.
Fig. 18.—*Epithema sp.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X715.
Fig. 19.—*Scoleotropis latestriata* var. *amphora.* Little Badgerup, Waneroo District, W.A X435.
Fig. 20.—*Diploneis elliptica.* 18"–24" layer, Ewart's Swamp, Grassmere, W.A. X715.
Fig. 21.—*Cymbella heteropleura.* Lillicur, Victoria. X640.
Fig. 22.—? zone view of *Navicula* cf. *radiosa.* Lillicur, Victoria. X410.
Fig. 23.—*Stauroneis anceps.* Little Badgerup, Waneroo District, W.A. X715.
Fig. 24.—*Pinnularia nobilis.* Lillicur, Victoria. X410.

The figures have been drawn by Miss Joyce Gilbert-Tomlinson of the Bureau of Mineral Resources, Canberra.

PLATE 2.

Fig. 1.—Moranding, near Kilmore, Victoria.
Fig. 2.—Lillicur, near Talbot, Victoria.
Fig. 3.—Happy Valley, near Linton, Victoria.

All figures X420.

PLATE 3.

Fig. 1.—Bishopsbourne, Tasmania.
Fig. 2.—Bunyan, near Cooma, New South Wales.
Fig. 3.—Newham, near Woodend, Victoria.
Fig. 4.—Bell's Mountain, Barraba, New South Wales.

All figures ×420.

PLATE 4.

Fig. 1.—Innot Hot Springs, near Mt. Garnet, Queensland.
Fig. 2.—Mickleham, Victoria.
Fig. 3.—Eight Mile Creek Swamp, Hd. Macdonnell, South Australia.

All figures ×420.

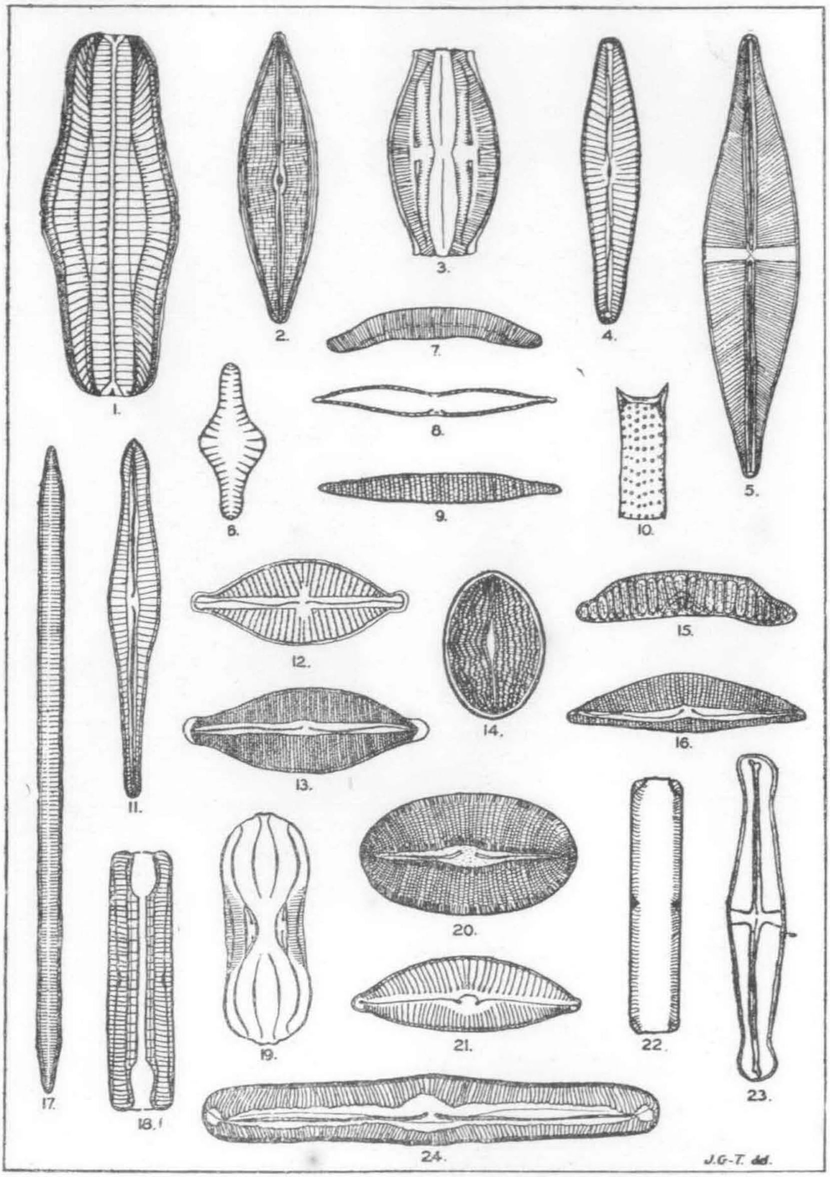
PLATE 5.

Fig. 1.—18"–24" layer, Ewart's Swamp, Grassmere, Western Australia.
Fig. 2.—Locality as in Fig. 1.
Fig. 3.—Locality as in Fig. 1.
Fig. 4.—Lake Gnangarra, Waneroo District, Western Australia.

All figures ×420.

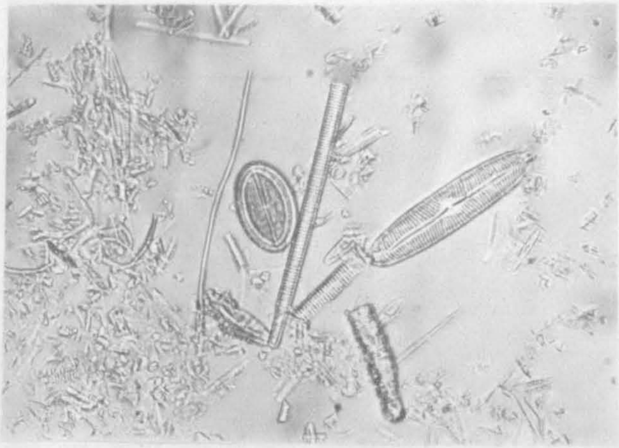
PLATE 6.

Map showing localities from which diatomite has been recorded.



TYPICAL AUSTRALIAN FRESH-WATER DIATOMS

Plate 1.



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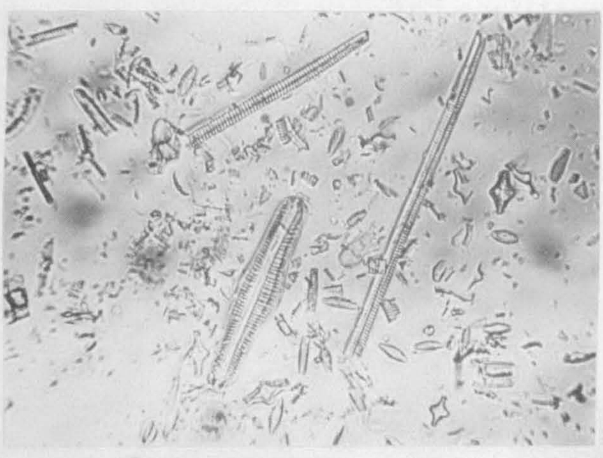

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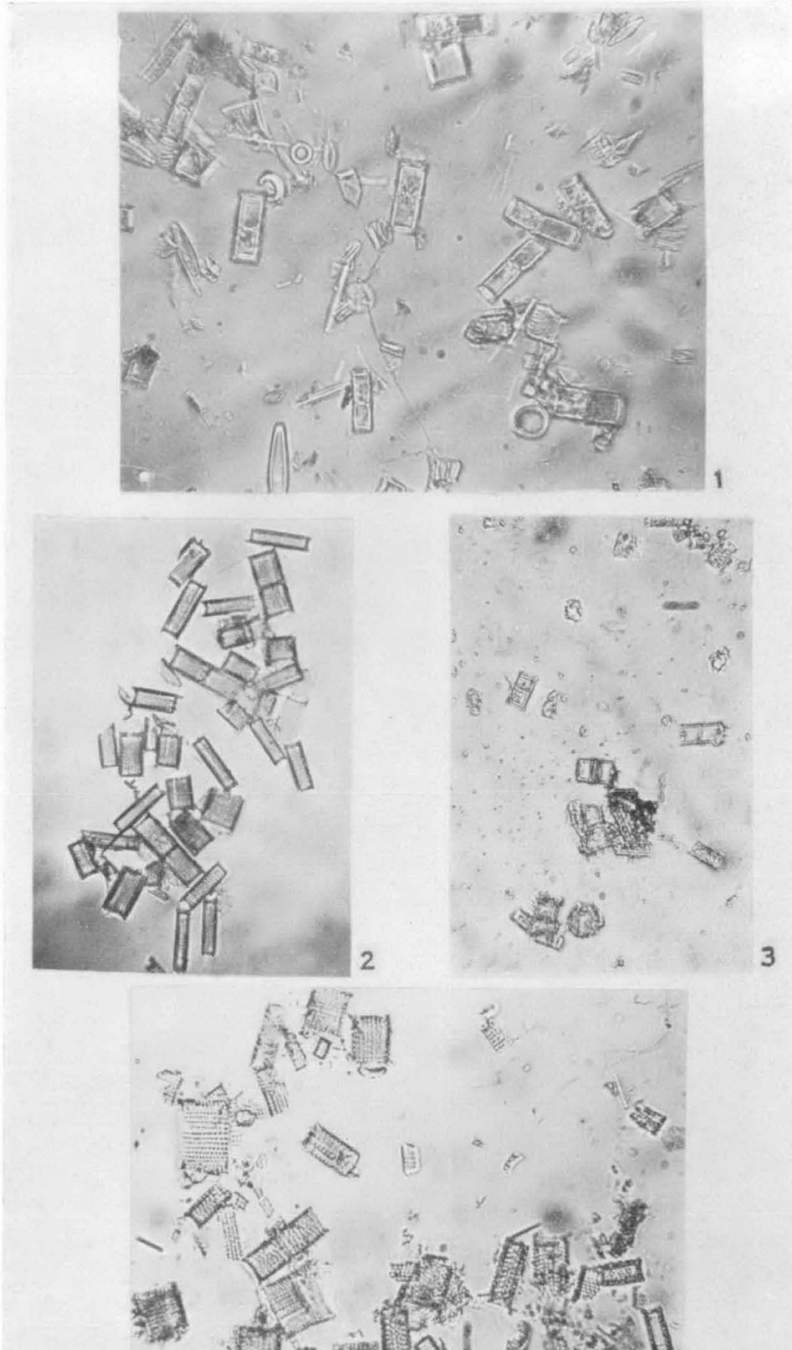
AUSTRALIAN DIATOMITES.

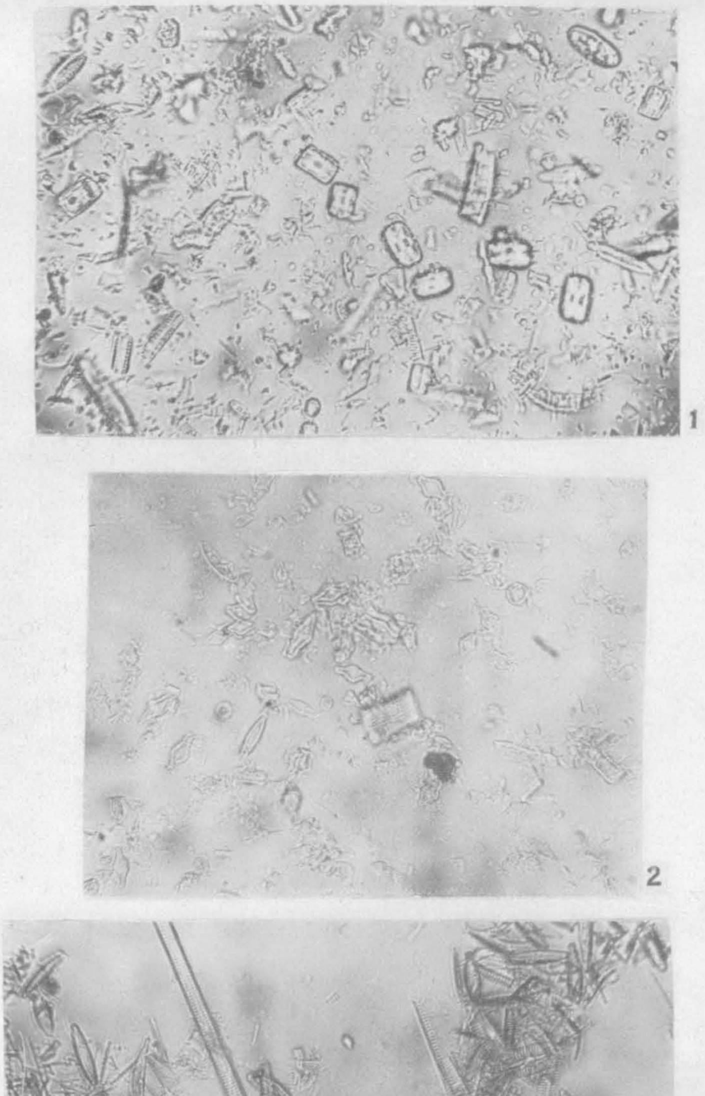
Plate 2.



AUSTRALIAN DIATOMITES.

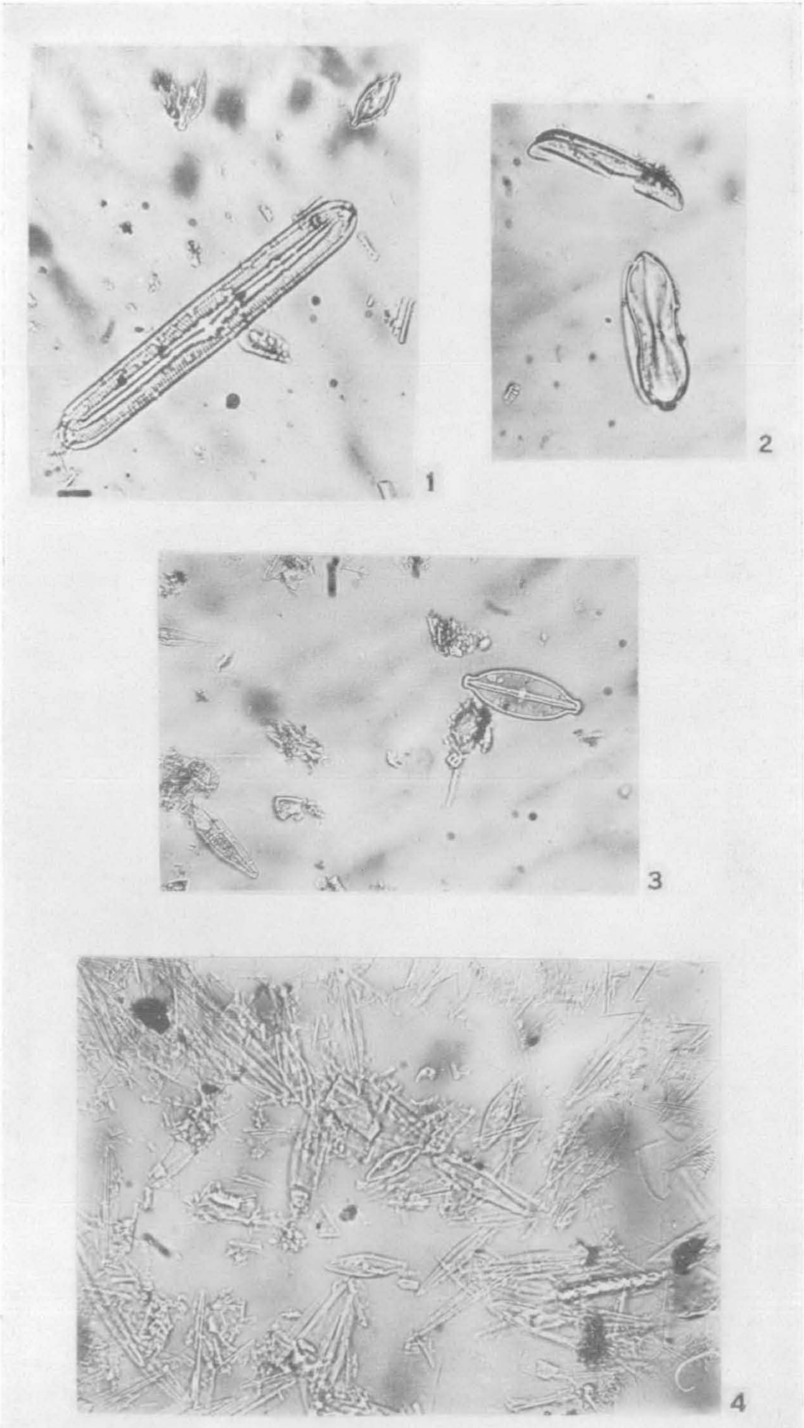
Plate 3.

1681.—3



AUSTRALIAN DIATOMITES.

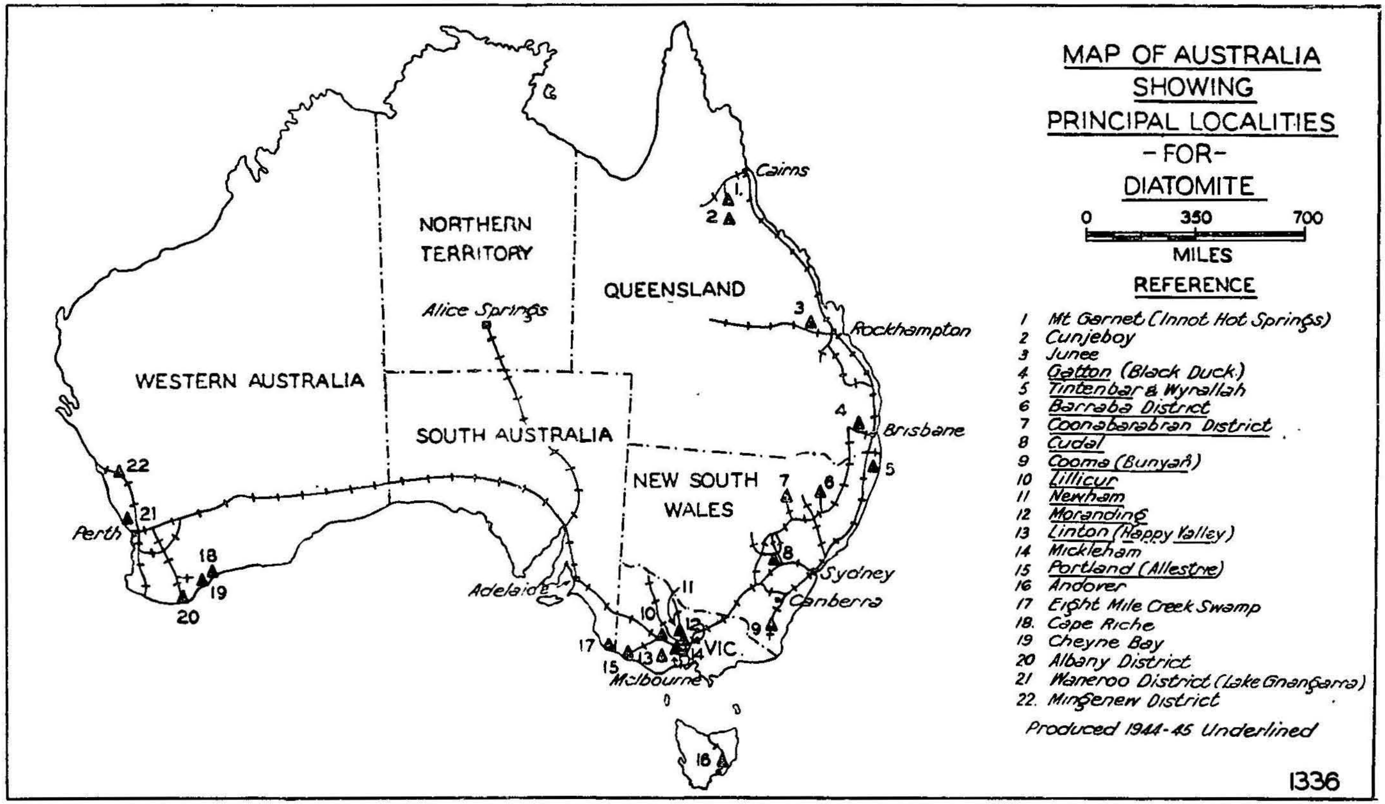
Plate 4.



AUSTRALIAN DIATOMITES.

Plate 5.

Plate 6.



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