these records from within the building is impossible in that the pollen and spores collected are automatically sealed between two layers of tape at the time of sampling.

Intraperitoneal injections into mice of spores collected with another sampler during the season of 1953 are now under way, as well as a further examination of our 1952 seasonal record.

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Cancer Research at a Marine Laboratory

So that workers in the field of cancer biology may be encouraged specifically to explore the almost limitless possibilities of marine organisms as tools for experimental oncology, an arrangement has recently been completed with the American Cancer Society whereby qualified investigators with cancer-oriented problems may work at the Lerner Marine Laboratory with all expenses paid, including transportation, full board and room at the Laboratory's residence, and the purchase of special equipment. Investigators interested in such support of their work should write to the undersigned: Chairman, Department of Fishes and Aquatic Biology, American Museum of Natural History, New York 24.

Of the various cancer studies so far carried on at the Lerner Marine Laboratory, some have employed eggs of marine organisms for large scale screening of presumptive growth-inhibiting substances, some have dealt with the effects of toxic extracts from marine organisms on the growth of mammalian tumors, and yet others have focused on the comparative cytology and physiology of normal and hyperplastic growths. Studies on purine and pyrimidine metabolism as related to growth are projected. Materials available at the Lerner Marine Laboratory would well be suited to experimental work on embryogenesis and the role of organizers, vitamins, and hormones in growth, proliferation, and differentiation. On the other hand, work undertaken at the Laboratory has been by no means limited to aspects of growth biology and the cancer problem. Studies in marine ecology, animal behavior, taxonomy, evolution, oceanography, etc., have been and will continue to be an integral part of the Laboratory's program.

Funds from private sources and from the American Museum of Natural History, together with grants from the Damon Runyon Fund, the American Cancer Society, and the U. S. Public Health Service, have contributed to the work carried on at the young Lerner Marine Laboratory. Here, at the eastern edge of the Gulf Stream, the Lerner Marine Laboratory stands far from the bustle of campus or metropolis, and yet only thirty minutes by air from the facilities of Greater Miami, Florida. The isolation so often longed for by scientists trying to do serious work at a student-crowded summer station, is on the Island of Bimini a reality. A steady semitropical climate permits operation of the Laboratory throughout most of the year; projects of nearly any duration may be undertaken. A profusion of experimentally suitable marine fauna and flora is available for easy collecting within a literal stone's throw of the Laboratory door. The Laboratory maintains fully equipped research rooms for ten senior investigators and their assistants, along with rooms or setup space for special studies in physiology, histology, pathology, biochemistry, aquatic biology, etc. Adjoining the main laboratory building is a spacious and comfortable residence where living quarters and meals are provided. Bimini, as one of the Bahama Islands, is under British administration, but no visa or passport is required of visiting American scientists.

The Lerner Marine Laboratory is a field station of the American Museum of Natural History. Although originally restricted to members of the Museum's research staff, its facilities are now offered to qualified investigators from anywhere in the world.

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The Hayward Fault of California at Its Type Locality

MAJOR earthquakes in 1836 and 1868, and many minor quakes since, convincingly show an active fault zone near the front of the northwest-trending hills that rise abruptly on the east side of San Francisco Bay. A fault in this zone has been traced for more than 60 mi, between San Pablo Bay and San Jose, and it may be much longer. It has been named for the town of Hayward, which sits astride it, about 15 mi southeast of Oakland. Although long recognized and frequently mentioned in geologic literature, the Hayward fault has been little studied in the field. As part of a larger project, about 9 mi of the fault zone near Hayward has recently been mapped in detail.

Near Hayward, evidence of active faulting is confined to a narrow zone where the hill front meets the San Francisco Bay plain. For 4 mi northwest of Hayward the zone is bounded by two rather well-defined fault traces, 1000 to 2000 ft apart, that isolate a row of undissected bedrock ridges—apparently "shutter ridges." For 4 mi southeast of Hayward only one active fault line was traced. It does not follow the hill front, which here is somewhat irregular but forms an inconspicuous, slightly sinuous, topographic sag a few hundred feet to 2000 ft back of the hill front. Parts of this long swale are undrained. Another roughly parallel fault line probably exists on the Bay plain about 2000 ft to the west, but it was not accurately located. For 2000 ft, in urban Hayward, the fault zone is in an alluviated plain that breaks through the hills; individual faults have not been traced across this plain.

Most stream courses are sharply offset to the north wherever they cross the fault zone. San Lorenzo Creek, a main west-flowing stream, cuts through the hills at Hayward, turns sharply northwestward, and follows the fault for more than a mile before resuming its westerly course. Offsets of other, lesser stream courses do not exceed a few hundred feet and, for most streams, are less than 50 ft.

There is stratigraphic, as well as geomorphic, evidence of horizontal movements. Southeast of Hayward, rocks of Upper Jurassic and early Pleistocene ages on the west side of the fault have apparently been shifted about 1200 ft northwestward. Nearly 4 mi of relative northward horizontal displacement of the west side of the fault may be inferred from the position of outcrops of the Knoxville formation of Upper Jurassic age; however, other interpretations are possible. Recurrent horizontal displacements clearly began in late Pleistocene time or earlier and have continued to the present.

The abrupt and rather straight, although dissected, hill front suggests vertical displacements on an essentially vertical fault plane. As shown by wells drilled on the Bay plain within a few hundred feet of the hill base, the steep bedrock front continues far below the Bay plain. In places, 650 ft or more of unconsolidated marine and alluvial deposits are banked against it. Total vertical displacement may have been far more than 1000 ft. Most of the vertical displacement happened so long ago that the original scarp has retreated and streams have cut away the rapids or waterfalls, which must once have existed at fault crossings. Thus, displacements of the last hundreds or thousands of years seem to have been largely horizontal.

The narrow Hayward fault zone is near the western edge of a broad faulted belt extending more than a mile back into the hills. In the hills are two long faults subparallel to the hill front, linked to each other and to the Hayward fault by short east-west transverse faults. The two long faults seem to be high-angle reverse faults with largely dip-slip displacements, the southwest sides having moved relatively up and northeastward. These faults, despite probable displacement of many hundreds of feet, are largely without topographic expression and seem to have been inactive for thousands of years.

Viewed broadly, the entire fault belt is well regarded as a single great fault zone. It is understandable that the term "Hayward fault" has gradually come to be applied to the entire mile-wide belt. This application has led to the widespread notion that the entire belt is equally active seismically and offers equal earthquake risk. But only a narrow strip near the hill front is clearly an active fault zone in which earth movements may reasonably be anticipated; most of the faulted belt in the hills offers much less short-term engineering risk. Particularly for this reason, it seems desirable to follow the original usage of the term "Hayward fault," and to apply it only to the narrow zone of definitely active faulting.

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Kaolin of Early Eocene Age in North Dakota

LIGHT-COLORED kaolinitic clays that comprise the lower part of the Golden Valley formation cap many of the divides and underlie several small synclines in southwestern North Dakota. The stratigraphic relationships and flora of the Golden Valley formation as a whole indicate an early to middle Eocene age, and the lower kaolinitic portion is almost certainly earliest Eocene, the time equivalent of at least a part of the Wasatch formation.

The kaolin must have once blanketed most of southwestern North Dakota and may have an even wider extent. A line circumscribing the outermost outcrops encloses an area of more than 6000 mi^2, and none of these outcrops suggests an approach to the original depositional limit of the clays.

Over their large outcrop area, the clays of the Golden Valley formation are remarkably uniform. Most exposures are 15 to 25 ft thick with the extreme range 5 to 45 ft. In gross aspect, most outcrops consist of three major units: (1) A basal unit of light purplish gray shaly clay, slightly carbonaceous and locally with numerous fossil plants; this clay is typically silty, but a few local lenses are plastic and silt-free. (2) A middle unit (missing in a few localities) of tough white sandy fire clay, mottled and stained yellow orange by iron oxides; the oxides seem to come from small limonite pellets that are the weathered relics of siderite pellets. (3) An upper unit of purplish gray clay similar to the basal unit; a thin impure lignite or dark carbonaceous clay commonly overlies the upper purplish gray clay and forms the top of the outcrops.

Locally the lower part of the formation grades laterally into a white crossbedded sand with a kaolin binder. The sand consists chiefly of angular to subangular quartz, as much as 20 percent angular calcite, 2 to 5 percent feldspar, muscovite, and about 3 percent heavy minerals, including garnet, tourmaline, kyanite, and others. The calcite is in discrete particles and does not appear to be a cement. Its origin is unknown. None of the minerals including the feldspars show signs of weathering since deposition.

Laboratory tests indicate that the clay beds consist chiefly of kaolinite (with minor amounts of halloysite or endellite), quartz, detrital mica, and some amorphous silica. The kaolinite is a fine-grained aggregate and shows no wormlike crystals or "books." Minor constituents consist of siderite pellets in the white fire clays, secondary iron oxides, and tiny veinlets of iron-