laboratory a number of tubes of radium of varying degrees of radio-activity, and sample tubes of polonium of both bismuth-polonium metal and nitrate of bismuth and polonium, each possessing a radio-activity 300 times that of uranium, and tubes of pitchblende, uranium, uranium residues from which the radium is extracted, etc. I have also secured through the courtesy of M. Boulay, of the Société Centrale, an interesting set of photographs made by radium rays.

DEVELOPMENT OF THE CERAMIC ART IN CHINA.

By RANDOLPH I. GEARE.

OLD Chinese legends contain statements to the effect that porcelain had been made in that country before the reign of Huang-ti, who came to the throne 2,697 years before the Christian era. Later legends refer to an official "director of pottery" and to the difference between molding and fashioning with the potter's wheel, which latter originally came from Korea. Sacrificial wine-jars, altar-dishes, coffins, cooking utensils, etc., were among the articles produced.

It has long been determined, however, that only earthenware could have been then made, nor can it be claimed that the manufacture of real porcelain (*tzu*) antedated the Han dynasty (B. C. 202 to A. D. 220). It is true that some porcelain bottles, decorated with flowers and Chinese inscriptions, are said to have been found in undisturbed Egyptian tombs at least 1,800 years B. C., but proof that seems conclusive has been furnished, showing that the inscriptions were written in a style not introduced until B. C. 48, and later these same inscriptions were identified as quotations from poems written during the T'ang dynasty (618 to 906 A. D.).

The opinions of two eminent authorities on this point are of interest and importance. M. Julien has expressed his belief that true porcelain was first manufactured in China between the years 185 B. C. and 87 A. D., while M. du Sartel, who published an exhaustive work on Chinese ceramics, places the date some centuries later, i. e., during the T'ang dynasty.

But however this matter of date may be, whether during the Han or T'ang dynasty—and the point is certainly not without interest—it is asserted beyond question that no specimens manufactured previous to the Sung dynasty (960 to 1259 A. D.) have survived to the present day, and the vexed question is therefore largely one of historical importance. Furthermore, the productions of the finer kinds even in the Sung dynasty have entirely disappeared. Those which have survived are said to be only "celadons" of considerable solidity, or small pieces of no great fineness. "The word celadon," writes Mr. Hoppisley, "was originally the name of the hero in the novel 'L'Astrée,' written during the sixteenth century. This hero was attired in clothes of a kind of sea-green hue with gray or bluish tint, and his name was subsequently applied to the clothes he wore." The Chinese equivalent of the word is "ch'ing," which is applied to the colors of porcelains of a blue, or a pale dull green."

Before discussing the principal characteristics of the porcelains made under the various dynasties, brief consideration will be given to the composition of Chinese porcelain, the method of shaping the paste, applying the glaze, and baking and decorating the objects, and it is but proper to add that the statements are largely derived from the catalogue of Mr. Alfred E. Hoppisley, a recognized authority on the subject, who has for many years been connected with the Imperial Maritime Customs Service of China, and whose collection of Chinese porcelains is now on exhibition in the National Museum at Washington.

Porcelain consists of two essential parts: one infusible, the other fusible. The former is the paste (*pâte*), which forms the body of the object; the latter is the glaze, which gives transparency, and prevents porousness or the possibility of the object contracting under the influence of heat. The paste, which may be hard or soft, is made up of clays. These are classified according to their degree of plasticity and fusibility. The best of them is kaolin; which is a white aluminium silicate produced by the decomposition of granitic or feldspathic rocks, and is almost infusible. The soft paste contains limestone products or alkalies, which lower its degree of fusibility, so that it becomes fusible, or at least soft, at a temperature of 800 deg. Centigrade.

The crude kaolin, when freed from all impurities and ready for use in making the paste, gives a very white clay, soft and plastic. The kaolin which furnishes the glaze for the hard Sèvres, is found in abundance at Saint Yrieix, in France. The paste is roughly shaped, turned and molded when in a malleable state. It is not cast, as in Europe, and therefore the skill of the Chinese in shaping with the hands large jars and cups as thin as egg-shell is all the more astonishing. They also seem not to have learned the advantage of baking the article slightly before applying the glaze. The fact that porcelain is dilutable by water (although ceasing to be so after exposure to a temperature sufficient to turn it red) furnishes an easy method of covering it with glaze. Being slightly baked, it may be covered with a uniform layer of glaze by simply immersing it in water bearing in suspension the finely crushed material, provided that the proportions of water and glaze (with relation to the thickness of the vessel to be covered) have been fully determined. The glazes used in China are for the most part compounded from substances whose proportions vary according to their nature. Pure petrosilex (a cryptocrystalline mixture of quartz and feldspar) is seldom used, but lime added to it renders it more easily fusible, and in some cases represents as much as one-fourth of the total weight. Fern leaves also sometimes enter into the composition of the glaze, although what purpose they serve has not been fully ascertained.

Being ignorant, as already intimated, of the plan of subjecting the porcelain to a preliminary baking (under which the vessel, on account of its thus becoming less porous, may be immersed into the liquid glaze) the Chinese apply the glaze by "aspersion and immersion," or else by "insufflation." In the first of

these processes the vessel is held by the outside slanting over a basin containing the liquid glaze. Enough of the glaze is then thrown on the inside to cover the surface. The outside is then immersed in the liquid. In employing insufflation, a piece of gauze is first attached to a hollow tube, and having been plunged into the glaze, the operator scatters the liquid over the vessel by blowing through the opposite end of the tube. The next operation is baking in the kiln, the bottom of which is covered with a thick layer of gravel. On this the "seggars," which are vessels of some refractory material that hold the pieces of porcelain, are piled. The object of the "seggars" is to prevent the pieces from coming into direct contact with the flames or gases. The pieces are still soft and must be placed in the seggars with great care, a contrivance of cords and sticks being used for the purpose. Then the piles of seggars are bound tightly together and the doors of the oven are shut. A low fire is kept up during the first twenty-four hours, after which the heat is increased. When the porcelain is sufficiently baked—and this is ascertained by applying a pair of pincers through holes in the top of the kiln, which are covered up during the baking—firing is stopped and all openings are closed for three to five days. This completes the operation.

In China the coloring processes used in decorating porcelain are two-fold: *colors du grand feu* and *colors de moufle*. In the former, the blue decoration under the glaze is made with a brush on the unbaked porcelain, the coloring matter being peroxide of cobaltiferous manganese. Other colors, such as celadon and red grounds, also seem to be used, although some authorities consider their production, in China at least, as due to accident rather than design. The *fond laque* or *feuille morte* is obtained by the use of oxide of iron. Black grounds are produced in a variety of ways, either by the thickness of the colored glaze, or by laying several shades of different colors one on another; or, again, by laying a blue glaze on a brown *laque*, or *vice versa*. One writer states that violet, turquoise blue, yellow, and green grounds are applied on the porcelain after it has been fired at a high temperature. All of these colors contain a rather large proportion of oxide of lead. The green and turquoise blue owe their colors to the presence of copper; the yellow to lead and antimony; and the violet, to an oxide of manganese containing only a little cobalt.

In Europe *colors de moufle* are obtained by mixing one oxide or several metallic oxides together in a vitreous flux, the composition of which varies with the nature of the color to be developed. In China, on the contrary, the oxides are dissolved, which has the effect of closely connecting the colors with enamels. Transparent enamels are vitreous compounds, the composition of which varies, according to the amount of fusibility required. Blues are supplied by oxide of cobalt; greens, by protoxide of copper; and reds, by gold. Opaque enamels, yellow or white, owe their color and opacity either to antimony, or to arsenic or stannic acid. In European porcelains these were found to scale off; but this is not the case when placed on Chinese porcelains. This is explained by the fact that the paste of Chinese porcelain being more fusible than the European, the glaze must also be more easily fusible, and the lime which is introduced into it to increase the fusibility, adapts it in some manner for closer union with the compounds forming the enamel.

None of the Chinese colors contain much coloring matter, and they are of but little value unless applied in a depth which gives the painting a relief that cannot be obtained in any other way. The harmony of the decorations thus obtained, results from the nature and composition of the enamels.

Commencing with the Sung dynasty (960 to 1259 A. D.), earlier than which there are probably no pieces of Chinese porcelain extant, the ware manufactured appears to have excelled all that preceded it, excepting perhaps one kind; and it is worthy of note that prior to this dynasty the external color of all porcelain was apparently determined by that of the glaze. In most cases only one color was used, while in a few instances vases were covered with parti-colored glaze and the different shades were liable to flow into one another in the kiln, thus forming by accident a class of objects whose decoration changed during the process of baking. The shapes and ornamentation appear to have been copied from ancient bronzes, or else the vessel took the form of some natural object. The principal porcelains made during this dynasty are the Ju-yao or Juchou, Kuan-yao, Ting-yao, Lungch'uan, Ko-yao or Chang-yao, Chün-yao, and many others of less prominence.

The finest specimens of Juchou, usually very thin, were delicate plates and bowls, with either plain or cracked surface, and with the ornamentation under the paste. A perfect vase of this period is considered almost unique and exceedingly valuable.

The Kuan-yao was the official porcelain, and was made at the imperial factories between 1107 and 1117. Some pieces were pale white, like the moon; some pale bluish-green; and others, dark green. Later pieces were colored only bluish-green, both dark and pale in tint. This porcelain was very thin, and sometimes was cracked so finely as to resemble a crab's claws.

Ting-yao porcelain was of two kinds—Pei-ting and Nan-ting (Northern Ting and Southern Ming). The former was the more highly prized, and the pieces were brilliant white, purple, or black.

In the Lungch'uan porcelain, the ornamentation was under the glaze, the shades of which varied from the color of grass to a deep onion green, with occasional bands of foliate or scroll pattern of a deeper tone.

When the court was removed southward in 1127, two brothers, Chang by name, gained a high reputation for their porcelain, which was made at a factory in the Lungch'uan district; but in separate kilns. That manufactured by the elder brother was called Ko-yao, while the ware of the younger brother was known as Chang-yao. Both were celadon in color, and the chief difference between the two seems to have been that the Ko-yao was crackled, while the other kind was not.

Chün-yao porcelain was sometimes molded in gro-

tesque form, but was usually fashioned after ancient bronzes and ornamented with scroll or floral patterns under the glaze. The best pieces seem to have had two or more colors of glaze on the same vase.

In the following dynasty, Yüan, which lasted from 1260 to 1349, the manufacture of porcelain seems to have fallen behind, excepting in the case of objects produced for the special use of the Emperor, while in the Ming dynasty (1368 to 1649), there was made considerable progress in the ceramic art, both in the fineness of the ware as well as in the excellence of the decorations. It is to the early part of this dynasty that the ornamentation of vases with arabesques and scroll-work, with landscapes, historical scenes, etc., has been commonly ascribed.

Decoration in many colors came to be more highly prized, and designs were obtained from the brushes of the best artists, which were afterward transferred to the porcelain by the most skilled workmen. The Ch'enghua period stands most prominently forward in this dynasty, so far as the porcelain industry is concerned. Then followed the Yunglo period (1403 to 1424), during which much white porcelain, with ornamentation in blue under the glaze, was manufactured. The blue employed in these periods is said to have been brought from some Mohammedan country as tribute, and hence was known as "Mohammedan blue." Eggshell porcelain of very delicate workmanship was now produced. The Chinese call it "t'o-t'ai," or porcelain from which the "embryo" or biscuit has been removed.

Next in order is the Hsuantê period (1426-1435), and among the porcelain of this period the kind which was covered with crimson glaze, or bore designs in that color, is said to hold the highest place in the eyes of Chinese connoisseurs. Another style of decoration was "three red fish on a white ground pure as driven snow, the fish boldly outlined and red as fresh blood, of a brilliant color dazzling the eyes." Still rarer styles of decoration were three pairs of peaches in red on a white ground, and a "white ground decorated inside and outside with cloud scrolls engraved in the paste, a scroll border above colored crimson, the handle a dragon of bold design molded in high relief coiled round the top, with teeth and four claws fixed in the rim, enameled vermilion red."

During the Ch'enghua period (1465-1487) the production of blue porcelain, bearing a blue decoration under the glaze, continued, but the supply of blue from abroad had become exhausted, and for this reason, coupled with a growing preference for ornamentation in enamel colors, this ware was inferior in color to that of the Hsuantê period. There were five more periods in this dynasty: The first was Hung-chih (1485-1505), in which a light yellow color was most in vogue, although enameling in color was also employed. The second was Ch'engtê (1506-1521), in which period decoration in enamel colors continued, and further supplies of the Mohammedan blue were obtained, which caused attention to be again turned to the production of porcelain ornamented with blue under the glaze. In this period also a curious kind of earthenware was made. Teapots of this ware were of a light brown or covered with a vermilion glaze. The third was Chiaching (1522-1566), during which the yellow glaze was abandoned, and decoration in enamel colors nearly died out. The old ornamentation in blue under the glaze was chiefly admired, and to the present day the "blue and white" of this period is much sought after. The last periods of this dynasty were the Lungch'ing (1567-1572) and the Wanli (1573-1619). It now had become difficult to find good clays, and this fact, combined with increasing political disorders throughout the empire, caused a marked deterioration in the quality of the ware produced, although good workmanship was sometimes effected, the most highly prized having marks on them resembling "millet grains," or a surface marked as with the pittings on orange peel.

The Ming dynasty was now at an end, and with the year 1644 the present dynasty commenced. The great factories at Ching-tê-chên, which had been closed for some years, were reopened when the Manchu emperors were firmly established on the throne, during the reign of K'anghsi (1662-1722). This emperor and his two successors, Yungch'eng (1723-1735) and Chienlung (1736-1795), advanced the ceramic art to the utmost degree. The ablest artists were employed, and the workmen and decorators were specially educated to a high level of proficiency. So rapid was the progress made that between 1698 and 1773, the manufacture and decoration of porcelain in China attained a degree of excellence probably never reached before or since.

Green was the predominating color for decoration during the early part of K'anghsi's reign, and hence the name *famille verte*, which was applied to this porcelain. Later, green gave way to red, and a style of half tints and broken colors with a base of carmine to pale rose was the distinguishing feature. With the addition of yellow derived from antimony, and white from arsenical acid, the variety and beauty of the decorations were greatly increased.

In 1727, after Yungch'eng came to the throne, Nien Hsi-yao was made director of the imperial manufacturing factories. His products, known as Nien porcelain, were graceful in form and of fine workmanship. They were chiefly monochromes, of blue, bright and carmine reds, celadons, and "of egg color as bright as silver." The monochrome vases became extremely fashionable, and one small vase, only eight inches high, was not long ago sold in New York for fifteen thousand dollars. After Nien Hsi-yao had had charge for fifteen years, T'angying succeeded him, and the objects made under his orders were remarkable for delicacy of workmanship, purity of form and brilliancy of coloring. He is also credited with the invention of several new styles of decoration, such as the use of European blues and violets, a ground of enamel black, white flowers or designs in gold on a black ground, etc. About the same time an opaque-white vitreous ware was introduced for making small articles, such as snuff-bottles, wine-cups, etc.

When Chienlung came to the throne, there became noticeable a decided change in the style of ornamentation, due probably to the influence of foreign designs,

and especially to the importation of designs from Persia to be copied in China, or porcelain ordered from that country. It was at that time that European nobles and men of wealth conceived the idea of ordering services of porcelain from China, bearing their family arms. The plates bearing the arms of England, France, and the Netherlands, still preserved at The Hague, date from the first half of K'anghsi's reign, but the great majority are of later origin. Chienlung was succeeded by his son Chiaching (1796-1820), and all art languished under his feeble-minded rule, but under his second son, Taokuang (1821-1850), in spite of internal difficulties caused by wars with France and England, some attention was given to the ceramic art, and the porcelain made for his own use compared favorably with that manufactured under some of his more worthy predecessors, and is at the present day much sought after by Chinese connoisseurs.

The last period to be considered here included the years 1862 to 1874, when T'ungchih was the Emperor. The manufacture of porcelain was renewed, and great attention was paid to its improvement, and the same remark applies to the next reign, which began in 1875. Some of the decorations in *sepi* are of a high order of merit, another style which came much into favor consisting of flowers and butterflies in black and white on a pale turquoise ground. But in more recent years the most marked advance has been made in the reproduction of the *famille verte* decoration—which was mentioned in alluding to the work of the first half of K'anghsi's reign—and of plum blossom on black grounds.

ITALIAN ENDURANCE OF ARCTIC COLD.

THE narrative just issued by the Duke of Abruzzi, in which his Royal Highness gives his personal experiences of life and exploration in the Arctic zone, is followed by the report of Capt. Cagni, commandant of the "Stella Polare," on a sledge journey to the highest degree of latitude yet reached, and wound up by the medical "relazione" of Dr. Achille Cavalli Molinelli on the hygienic aspects of the expedition. A few excerpts from Dr. Cavalli Molinelli's report may not be unwelcome.

To begin with, Italians have always shown themselves capable of enduring, not only a very high, but also a very low temperature—the latter fact made memorable by Baron Larrey, Surgeon-General to the Emperor Napoleon's "Grande Armée" in the disastrous retreat from Moscow in 1813, when, of all the contingents, Murat's 10,000 Neapolitans were found to have suffered least, not only from the physical privations common to the whole army, but even from the cold, which was as prolonged as it was intense. This observation of the French surgeon is confirmed by Dr. Cavalli Molinelli, according to whom the health of all on board the "Stella Polare" was excellent—the only exceptions being the Duke himself and Commandant Cagni, whose scientific zeal so outran their prudence that they suffered severely from frost bite, resulting, in the commandant's case especially, in lesions affecting the hands and even costing him several fingers.

Increase of weight during the winter was observed in a number of the party, who felt greatly better than in their native Italy. Colds, from which they suffered habitually at home, they quite got rid of, although they had often to pass (without taking special precautions) from 15 or 18 degrees above zero in their

THE NAVAL WAR GAME BETWEEN THE UNITED STATES AND GERMANY.—IX.*

By FRED T. JANE.

OPERATIONS OFF KIAO CHAU.

As already related, the German fleet retired to Kiao Chau, there to be blockaded by the American vessels.

This acceptance of a blockade was taken by the Americans to indicate that several German ships were so damaged at the Manila fight as to be now useless. As a matter of fact, however, this idea was only very partially correct. The "Kaiser Friedrich der Dritte" certainly needed repairs, but the main object of the Germans in allowing themselves to be blockaded was a strategical ruse. By means of it they secured a heavy initial advantage in ability to choose their own time for fighting, and to have that fight with full bunkers. As, however, the Americans were accompanied by colliers and were allowed their claim to have these fitted for coaling at sea, they too were enabled to keep their bunkers fairly full, and no ships had to be absent, as at off Santiago in the Hispano-American war. In one respect, therefore, the German side drew a blank. They were waiting at Kiao Chau

chusetts." Should speed be urgently needed, the American fleet was, therefore, in a position to detach a strong, swift force, one that roughly represented half its total strength.

It may not be without interest at this juncture to compare the fleets by the rate values assigned to classes in the "All the World's Fighting Ships" (Munn & Co.) classification.

U. S. Fleet.

3 "Maines," Rate I at 1.0 each.....	=3.0
1 "Alabama," Rate I at 1.0 each.....	=1.0
1 "Kearsarge," Rate I at 1.0 each.....	=1.0
2 "Indianas," Rate II at .8 each.....	=1.6

6.6

German Fleet.

2 "Wittelsbachs," Rate 1 at 1.0 each....	=2.0
5 "Kaisers," Rate II at .8 each.....	=4.0
1 "Bismarck," Rate II-III at .7 each....	=.7

6.7

Bearing in mind that the Americans had the advantage of two destroyers with them against the German advantage of greater homogeneity of units, it

NAVAL WAR GAME. OPERATIONS OFF KIAO CHAU—FIRST STAGE.

tent to 35 or 40 degrees below it in the open. Dr. Cavalli Molinelli attributes this result to the absolute purity of the atmosphere without dust, and calls attention to the fact that more than one of these subjects when nearing the coast "was seized with a sudden and continuous desire to expectorate."

The rigorous limitation of fermented liquors in the dietary and the prohibition of distilled alcohol had also their invariable effect in maintaining the health of the party. Dr. Cavalli Molinelli allowed no cognac, rum, or whisky to be taken except on rare and special occasions as a condiment or as medicine. Wine was conceded only in small quantity at supper—about 120 grammes of "barolo" (a dark-red "blood-making" wine) or 60 grammes of port. The good results from this regimen were conspicuous, he adds, not only in the excellent hygienic conditions above referred to, but also in the temper of the party, alacrity and cordiality always prevailing among the subalterns. Nor was it only among the Italian nationality that these effects were seen. The Norwegian contingent, inured more or less to the ingestion of alcohol, and using beer as a constant beverage at home, were manifestly better for the abstinence from these drinks, as practised on board the "Stella Polare" and on the sledge journeys. —The Lancet.

till one of the "Maine" class should be absent, and for this they waited in vain. After a ten days' quietness, the Americans lying below the horizon were informed by two destroyers that were with them that the German fleet was coming out.

It came out in line ahead in the order indicated in the diagram. (In all these diagrams Kiao Chau lies to the right.) The two best ships, "Wittelsbach" and "Zaehringen," were at the head and tail of the line respectively; the weakest, the "Kaiser Friedrich III." and "Fürst Bismarck," occupied the center.

This formation of a line is good, a weak "tail" being the worst of drawbacks, since it invites attack in that quarter.

The American formation-order, from this point of view, was not so good. The ships were, however, disposed to meet a different contingency, one in which speed was the principal factor. For that reason two squadrons were formed, the first of the three homogeneous and fast ships of the "Maine" class, the second of the remaining non-homogeneous and slower ships "Alabama," "Kearsarge," "Indiana," and "Massa-

may be said that the fleets were as nearly equal as might be.

It was this equality that led to the ultimate fiasco. In view of the issues at stake, neither side cared to join issue without some considerable tactical advantage at the start. An attempt to secure such an advantage led to the interesting though abortive evolutions under review. Special interest attaches to them because of the theory, now gaining ground so rapidly in most navies, that the battle of the future will be fought and won before range is reached and before a gun is fired. The fighting, by this theory, will merely determine the magnitude of the victory.

The first tactical aim of each rival admiral was to concentrate on the tail of the enemy's line, a consummation that the Germans could have stood better than the Americans. In consequence (Diagram I.) the two fleets proceeded to circle, at a range that varied from 13,000 to 11,000 yards between the nearest ships. Firing at such a distance stood to be pure waste of ammunition, and neither side attempted it.

The average German speed was considerably higher than that of the Americans, whose ships also made no attempt at top speed, doing 10½ knots while the Germans (also economical) did about 12.

Subsequently both sides increased speed somewhat,

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