Chapter I

GENERAL CONSIDERATIONS

CHINESE ceramics can be approached and studied from several different angles. The most interesting, or at all events the most popular, is from the aesthetic standpoint, and most that has been written on the subject for the help and guidance of its students is based upon archaeological researches, coupled with the scrutiny and translation of Chinese texts.

The approach in this little book is from a different point of view, the scientific one. Most people who are interested in the subject know the general story of Chinese ceramics and have seen many examples dating from the earliest times down to the nineteenth century, of which all but the latest work was displayed recently in profusion at the Chinese Exhibition at Burlington House. Our museums have notable collections where students can study shapes and general characteristics, while a range of books of an authoritative nature on those aspects can be consulted. On the other hand, little has been written about the scientific aspect of Chinese ceramics, at all events for the particular information of collectors of the wares. One reason perhaps is that it is difficult to make the chemistry and physics of glazes intelligible and interesting to those who do not possess much technical knowledge. It is not easy to explain adequately the factors that have operated to bring about certain effects without plunging into a mass of technical detail which leaves the reader even more puzzled than at the outset. But that is no reason why an attempt should not be made.

A wide range of glaze effects was produced by the Chinese potter over the long period of time extending from the Han dynasty down to the time of the Manchus, and it is well to record at the outset the great technical knowledge displayed by the Chinese potter. The more the glaze effects produced in early days are examined scientifically, the more impressive becomes his knowledge. He may not have used the jargon of the scientist of to-day but he obviously approached his task in a scientific fashion. His power of observation and deduction went near to what we term scientific method, and his close repetition of previous processes, arising from observation, helped him to produce what to-day is admired so much. Probably many of the well-known glaze effects were brought about by accident rather than by design in the first place. Something went wrong and an entirely different result was produced in the place of the expected. If the appearance was pleasing, the potter noted it and tried to repeat the accident: he probably failed in the attempt or obtained only a partial success; but further trials led to a mastery of the process. There is a good deal of evidence that this was so, although we need not place too much importance on the legendary account of how the potters of Chi-chou fled in terror because their wares turned suddenly into jade during the visit of a high official: or on the story of how the potter T'ung threw himself into a kiln in despair of executing an Imperial order, to bring about miraculous results and his own deification in consequence.

Potters of to-day look forward with excitement to the "drawing" of a kiln. A great variety of effects may be produced by relatively small and chance variations in the conditions inside the kiln and the potter can never tell with certainty what will have been the result. The most skilled potters may have to fire a hundred pieces in order to get one or two specimens of the special effect they seek. The object of this book is to try and explain some of the chief underlying facts that determine how different glaze effects come about and to describe in a measure the host of factors which come into play to cause the varying results that arise.

NATURE OF A GLAZE

The first thing to realise is that a glazed vessel consists of a pottery or porcelain body over which has been laid a layer of glass; and glass is to be regarded as a super-cooled liquid which under stress of heat becomes fluid again and can flow readily. If a piece of bread were spread with a thin layer of butter upon it, an analogy to a piece of thinly glazed pottery or porcelain would be furnished. If a spoonful of syrup or treacle were smeared upon the piece of bread, the counterpart of a thickly glazed vessel, such as those found in the Sung wares, would be produced. Butter in hot weather becomes "runny" and syrup is more fluid when hot than when cold. Human beings exist best in a temperature at which glass is apparently a brittle solid and not a liquid. Pitch is another example of a super-cooled liquid which is a brittle solid at low temperatures.

It will be convenient to group the glazes to be described into two main classes, the felspathic glazes and the lead silicate glazes. The former are made from materials rich in felspar, a mineral widely distributed in the world and consisting of silica, alumina and alkali in combination. It is an essential ingredient in the Chinese *petuntse* or "little white bricks", so called because the felspathic rock was pulverised finely, washed in water and finally converted into a smooth white paste which was made up into small blocks for the potter's use. *Petuntse*, like our Cornish stone, consists roughly of one-third felspar, one-third white clay and one-third quartz. Père d'Entrecolles, in his well-known letters, says the Chinese potters liked *petuntse* which showed cypress-green streaks. Similar streaks occur in some varieties of Cornish stone. The felspar glaze material, used centuries before Père d'Entrecolles' time, was similar but less carefully prepared and refined.

A glaze consisting almost entirely of felspar is somewhat difficult to melt or fuse and therefore to manipulate: it was put on the body thickly in the early days before the potter had learned to cope with it satisfactorily by modifications of the ingredients of the glaze and of the firing conditions. Later, the potter learnt to handle it more readily and found no difficulty in applying it thinly. Even in some of the Sung wares this type of glaze is found in very thin layers. The difficulty of their application arose not so much from the fact that they were hard to fuse, but because they had a high viscosity. Being viscous or treacly in consistency, they flowed very sluggishly when fused, and the glazes were thickly applied to lessen the risk of imperfections or loss arising from unhealed scars and the like. Incidentally, a depth was obtainable that would have been impossible with a thin and watery glaze, unless the latter was fused gently and for a long time at a comparatively low temperature. The length of time of heating a glaze is an important factor in getting it clear, for the slow fusion of the ingredients causes the disappearance of solid particles which by their persistence would cause a scattering of light and consequently a cloudy effect. If lead oxide is introduced, the glaze can be matured at much lower temperatures and, as fluidity is more rapidly secured and maintained, a thinner layer of it can be more easily obtained in the melted condition. These less viscous lead-silicate glazes were used in the pre-Sung wares. They were replaced by the viscous felspathic glazes in that dynasty but were re-employed later. They were used extensively as fluxes for on-glaze colours or enamel colours, superimposed on a groundwork of glaze of a felspathic nature. These enamel glazes were fired as a second operation at a lower temperature in what is called a muffle kiln.

The glaze is applied to the body in the following way. The glaze mixture, before being mixed with water to form a fine suspension, is prepared by one of two methods. The ingredients may be ground up together and mixed in that fashion. The glaze mixture is then termed "raw". Or, as is more commonly done, the intimacy is heightened by fusing them together in a frit kiln with considerable heat and then pulverising the glassy product subsequently. This latter method is called "fritting", and the product is called a fritted glaze. Felspar might be called "Nature's frit". The vessel to be glazed is then either dipped into the suspension or brushed over with it, or the suspension is sprayed on to it. After the vessel has been dipped in the glaze, the porous body sucks up the water and leaves behind a film of the glaze which previously was suspended in the water.

The vessel will have been previously thrown on the wheel and subsequently sun-dried in the case of the earlier more primitive bodies, or lightly fired in the case of the later porcelain bodies. Naturally the sun-dried vessel was of a stouter nature to give the necessary stability to the shape, whereas the vessels which were biscuited, as it is termed, in a kiln could be made much thinner. In either case, the vessel with its layer of fritted glaze evenly spread over the body was placed in a saggar or protective case

Cambridge University Press
978-1-107-50491-2 - Courtauld Institute of Art: Chinese Ceramic Glazes
A. L. Hetherington
Excerpt
More information

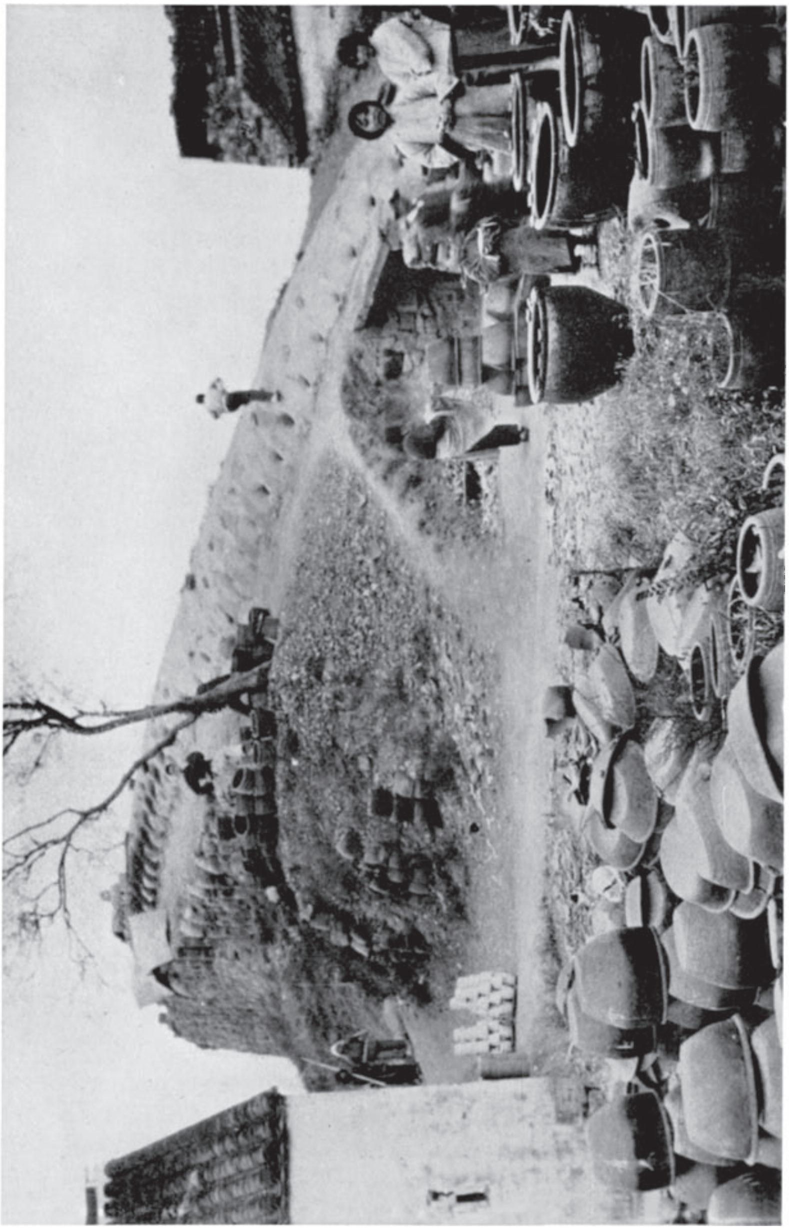

Plate I. A Chinese kiln at Tê-hua.

and fired in a kiln which was fed with wood as fuel. The high temperatures required were secured by what is termed an induced draught. The kilns were usually situated on a hill-side where the slope of the ground furnished the necessary draught. Plate I is a photograph of a Chinese kiln operating to-day near Tê-hua in the province of Fukien. The heat of the kiln first drove off all the moisture and then fused the glaze ingredients so that the vessel became coated with a layer of molten glass or glaze.

NATURE OF BODIES USED

Before going further it will be well to make a slight digression and say something about the different bodies used by the Chinese potters. In the Han and T'ang dynasties, the bodies consisted of clay which was hardened in the fire after the glaze had been applied in the suspended condition. The lead-silicate glazes employed at that time fuse at a relatively low temperature and the body in consequence was not high-fired. Sometimes the bodies of these early wares are soft enough to be scratched with a knife while others resist the treatment. The glazes no doubt varied somewhat and some fused at lower temperatures than others; further, the nature of the clay varied in different localities where the early factories were operating. It is known from the early literature that centres of ceramic production were established all over China in a widespread fashion in those times and all of them were making similar types of ware. It is easy to prove that the hardness of these early bodies is due in large measure to the degree of heat applied, for if a piece of T'ang ware, the body of which yields to a knife, is refired at a fairly high temperature, the body will become quite hard and will then resist the knife.

The earthenware bodies, consisting of clay with an admixture of such a material as quartz, gave a stouter material than a simple clay, and they were largely used in the T'ang dynasty. They were replaced by the stoneware bodies which were similar in nature. These were continued until the time arrived when an approximation to true porcelain was reached. These early porcelain bodies contained *kaolin* or china clay mixed with felspar, and it is known from the evidence of the Samarra fragments that bodies of this nature were freely made in China as early as the T'ang dynasty. The European and Chinese definitions of porcelain differ. We regard translucency as the determining test, whereas the Chinese attached more importance to whether the vessel rang when flicked with the finger. Some of the Samarra fragments will satisfy both definitions.

Kaolin in a pure state is a natural compound which contains alumina, silica and water, and it varies considerably in composition in the different localities where it is found. When it is mixed with felspar and fired, the latter melts and vitrification takes place throughout the body with the result that a translucency is imparted to a degree varying with the composition of the mixture and with the temperature applied. Even without the addition of felspar, a porcelain (in the European sense of the term) can be made from finely-divided kaolin, if it is heated to a sufficiently high temperature. The dividing lines between earthenware bodies, stoneware and porcelain are not nearly so clearly marked as popular opinion holds. It is possible to make a stoneware body, so called, transmit light if potted thinly enough and if the firing conditions are appropriate both as regards the degree of temperature employed and, equally important, the length of firing-time. There is a time reaction as well as a temperature reaction, and it is possible to produce at a relatively low temperature effects similar to those obtained at high temperatures if the firing time is sufficiently increased. The addition of the felspar assisted the vitrification process very much and allowed the process to go on at a lower temperature than would otherwise be required.

The close relationship between china clay (*kaolin*) and china stone, or *petuntse* as the Chinese call it, is not always appreciated. Felspar and felspathic rocks, like some of the granites, are susceptible to weathering, and when they disintegrate and become friable, they gradually break down and form china clay. The action is naturally a very slow one, but china clay is essentially decomposed felspathic rock. The alteration consists in the removal of alkalis and the formation of a hydrated silicate of aluminium, having the formula $Al_2O_3 . 2SiO_2 . 2H_2O$.

When a felspathic glaze is put on a stoneware body and fired, it will be found at the point of juncture that vitrification of the body has taken place, and it is legitimate to surmise that observation of this fact had a good deal to do with the production of porcelain as we term it. The Chinese potter may have observed from a broken vessel this layer of vitrified body under the glaze and noted how the glaze had eaten into the body, so to speak, to give a more or less translucent layer. He may have said to himself: "Why not put some of the glaze stuff (felspar) into the body and make that thin layer spread throughout the vessel?" The evolution of porcelain may have been initiated in some such way, especially when it was found that by using purer and more finely divided clay material the operation was improved.

SLIP

Kaolin was used for purposes other than making bodies. It was mixed with water to form a cream which is known as "slip". Slip was employed for two purposes; it was used as a luting material for joining sections of a vessel together. Large vessels were more easily fashioned, if thrown in sections and subsequently built up by joining the sections together with this mixture of the body and water. In a thinner suspension, slip was used as a decoration either with or without colouring matter; many of the early white wares owe their effect to a thin opaque white coating of slip with a transparent glaze superimposed upon it, providing as a result a beautiful creamy-white glaze. The Tz'ŭ Chou wares furnish good examples of the use of slip to produce this white effect and for decoration in a variety of ways. In Europe slip decoration is common enough. This clay suspension or slip can easily be run into moulds porous enough to absorb the excess moisture. In this fashion very thin vessels can be made, and in large quantities by mass production. The Chinese potter apparently did not use this moulding process to any large extent and depended on the wheel and his fingers for his shapes. That he was able to obtain excessively thin bodies by means of his wheel and paring tools is proved by the egg-shell bodies of which he was a master.

SCATTERING OF LIGHT IN A GLAZE

There are a number of reactions of a chemical and physical nature which it will be convenient to describe in order to make later reference to them easier. Bare mention has already been made of the cloudy effect in a glass or glaze due to the scattering of light from unfused particles contained in it. Scattering of light may be explained thus. A sheet of paper is composed of a mass of fibres of cellulose derived from wood or rags. These fibres interlace at various angles to each other. The paper looks white by reflected light and is fairly opaque by transmitted light. That result is due to the fact that light is being reflected from the fibres set at a variety of angles to each other. If the interstices were all filled up, and a homogeneous layer produced in consequence, the light would not be reflected back to the eye. The paper would look dark instead of white by reflected light and become much more transparent by transmitted light. The interstices could be filled by adding water or oil to the paper and the light would cease to be scattered. Or again, if a sheet of transparent glass is rubbed with emery paper, the transparency will disappear and a piece of ground glass will result. The light will be reflected from the intersecting roughnesses created instead of passing through. If the tiny hills and valleys of the roughened surface be smoothed out by polishing, the glass again becomes transparent and the light passes through. If the roughened glass is wetted, the hills and valleys will also be temporarily levelled up and the glass will become transparent or nearly so.

If there are a number of particles of solid material imbedded in the glass or if there are minute bubbles in the glass, light will be reflected back from their surfaces and a cloudiness or opacity results. The soft appearance of the early celadon glazes is caused in this way and the difference in them from the Ming celadons (or the Northern Chinese celadons), which are usually clear, is marked.

OXIDATION AND REDUCTION

Reference will be made shortly to the oxidation and reduction of glazes and it is necessary to make clear what is meant by those