CHAPTER 5
CONCLUSIONS

This thesis aimed to study basic properties and characterization of clay sources of ancient pottery, which were discovered at Ban Bo Suak kiln site. This research was divided into 3 parts. The first part was to studied characterization and physical properties of ancient Ban Bo Suak potteries. The second part was to investigate different clay sources of Ja-Manas kiln (JQA), Doi Fuang Moh kiln (FQB), Dong Poo Ho kiln (PQC) and Nong Tom kiln (NQD) and to select the clay that had similar properties to ancient potteries. The last part was to measure deterioration of SiO_2 content in selected time by autoclave and bury test.

5.1 Conclusions

5.1.1 Characterization and physical properties of ancient Ban Bo Suak potteries

First experiment explained characterization and consideration of coating technique of the ancient JQA.SH, FQB.SH, PQC.SH and NQD.SH samples. This research found that the main chemical composition of sherds was SiO_2> 71 % wt, while Fe_2O_3 content was high, in the range of 4-10 wt. % Fe_2O_3 content initiated the color of fired ceramic and influenced also the color of the natural raw clay. Other chemical compositions of sherds were K_2O, TiO_2, and CaO. The things to consider were effects of different chemical composition on phase transformation and color after firing process. XRF result indicated silicon oxide or SiO_2 was the major element of these ancient clays. Corresponding to XRD result, it indicated the main structure of all clays was SiO_2 quartz structure. The coke was revealed in body that was predicted as the incomplete combustion process.

5.1.2 Characterization and properties of different clay sources

Second part studied basic properties and characterization of different clay sources. The average particle size of JQA, FQB, NQD and PQC were about 11.48 µm, 9.63 µm, 8.21 µm and 7.96 µm, respectively. Clays normally mixed with water content for forming process. It was found that JQA, PQC and NQD had highest water content of 23-28.0 wt. %. While, FQB had the lowest water content of 23-24.0 wt. % because of the large particle size and high amount of free silica. Factors influencing plasticity might be related to the clay itself or to the forming process. XRD indicated large quartz phase and small kaolinite phase in theses clays. After being fired at 1250°C, quartz was still observed, while kaolinite phase was transformed and combined with some quartz to form tridymite and anorthite phases. Although Fe_2O_3 did not investigated in XRD result, however it was indicated in XRF result. This caused the red-dark color of the fired samples. Linear shrinkage values of clays after being fired at 1250°C were about 32.11 %, 30.41%, 37.10% and 34.65%, respectively. The highest drying shrinkage was obtained from PQC clay due to the smallest average particle size. After firing at 800-1250ºC, the linear shrinkage value of all samples was significantly increased with higher firing temperature. However, the linear shrinkage values of the clay samples were obviously increased after fired at 1250 °C, which related directly to lower water absorption. Moreover, linear shrinkage of clays increased with an increase of Fe_2O_3 content, which presented the fluxing effect. In pottery design, shrinkage value was an essential fundamental for the calculated size of green-ware sample because it was shrunk after firing process. The maximum shrinkage value was obtained for NQD clay, so the bending strength of NQD value 31.12 MPa. Besides, it was found that the bending strength was related to the higher mullite phase in the fired body at 1250°C. From the results, JQA clay source would be studied about quartz deterioration in the next part. Besides, this part investigated that clays could be endured from the fired at 1280°C without the warping defect.

5.1.3 Study deterioration from autoclave and bury processes

It is the nature of all materials to eventually degrade and deteriorate. Degradation of the objects occurs from interaction with the environment; defect in the matrix and with the materials that form the object. However, in the case of ceramics, defect in matrix are the major factor. There are several ways in which ceramics break down physically and chemically. Chemical agents can flow into these cracks and pores, reducing, thus, the bond between grains, making it easier for the erosion process and leaching the constituent materials. These transported constituents can induce the formation of new crystals resulting from chemical reactions. When the air humidity penetrates into the structure, these crystals are generally dissolved and carried to the surface, provoking thus, and stains on the ceramic artifact. If these water and salts remain inside the ceramic body, they will re-crystallize causing expansion, favoring thus, degradation of the material. In the study of the deterioration of fired samples from autoclave and bury processes, the fired JQA sample was selected to be tested. It was then autoclaved by varying time from 6 to18 hours with the constant pressure at 127 Psi. After autoclave test, XRF indicated that SiO_2 decreased with longer autoclave time. Similar to the bury test by varying times at 90, 180 and 360 days. SiO_2 was slightly decreased when the time increased. SEM micrographs confirmed the results of deterioration. It was seen that porosity tended to increased with increasing time of autoclave test. The same as the result of bury test, porosity increased with increasing time of bury. From the result in this part, it was implied that the fired sample could be deteriorated under the factor of pressure and heat. Mass of fired sample before and after test by autoclave and bury were found to be significantly reduced after test. This proved that pressure and heat could generate to both pore and crack defect in clay structure.

Pottery degradation is highly related to manufacturing processes and quality of raw material used. When ceramic body is buried, it is exposed to environmental factors which lead to the collection of substances and organisms. These factors including humidity seep into ceramic body via pores. This initiated all kinds of damages in potteries. They make the clay body fall apart so, with time passes, more amount of liquid can get into the potteries. Studying pottery deterioration will help us understand processes and factors that have effects on potteries, such as man-made and environmental factors and the areas where potteries are buried. Therefore, information gathered in this research might be useful in the future for archaeologists in that they are able to link scientific data with archaeology. Some part of information can also be used to help with conservation and storage of ancient potteries.

5.2 Suggestions

1. The time for autoclave and bury test should increase for consideration of degradation.
2. Scientific method should be applying to ancient pottery research.
3. Degradation of ceramic samples in the environment should be more investigated.
4. The study of microstructure and deterioration of ceramics help us understand the process to protect and preserve of historical object made from ceramic.