Early Astronmical and Magnetic Observations in Siam.

In two volumes describing his journeys to Siam and other matters (Paris 1686 and Paris 1689) Father Tachard has given some interesting information about astronomical and magnetic observations made by himself and other Jesuit fathers at the Cape of Good Hope and in Siam. It is proposed in this paper to collect and put in a narrative form the material and details furnished by the two books mentioned, and to review the results.

Tachard, as is well known, was the most conspicuous member of that band of six Jesuit mathematicians sent out by Louis XIV., under a royal patent, to carry out scientific work in the Indies and in China, in order, as the patent puts it, "to establish Security in Navigation and to improve Sciences and Arts." They accompanied the Chevalier de Chaumont, the first French Ambassador to the Court of Siam, leaving France on the 3rd of March, 1685, and arriving at the bar of the Menam on the 23rd of September in the same year.

During his short stay in Siam Tachard gradually became mixed up with the politics of the period and, at the instance of Constantin Phaulkon, the prime minister, who had persuaded the King of Siam to countenance the scheme, he returned to France with de Chaumont in 1686 with a royal request to Louis XIV. to send out another band of Jesuit mathematicians for permanent residence in Siam.

Tachard refers to this arrangement as follows :—

> "Not long after this Phaulcon conversed with the King about obtaining 12 Jesuit Mathematicians, with the idea of building an observatory similar to those at Paris and at Pekin. He explained to His Majesty the glory and utility which would

accrue to him and the advantage which his subjects would draw from these from which they would learn the most beautiful Arts and finest Sciences of Europe. The King consented to this project, and it was decided that Tachard should return to France for the Jesuits."

The following is an extract from a letter written by Phaulkon to Père de la Chaise :—

"The King my master having already ordered the Father Superior to select a site at Louvo, (Lopburi), and another at Ayutia, to build Churches, Observatories and Houses, which may seem to him proper, I undertake at the same time to give orders that all these will be ready to receive the Fathers on their arrival. If the six Mathematicians (the Fathers and my Brothers), have been able to accomplish so much in two months what will not fifty or more do in the space of twenty years."

This mission, owing to his religious fervour, was evidently one after Tachard's own heart, and he was completely successful for, whereas 12 Jesuits had been asked for, on the 1st of March, 1687, he set sail from France with 16 members of his order This second body of mathematicians travelled to Siam with the French fleet of four ships which conducted to the East M. La Loubere, the Envoy Extraordinary from Louis XIV. to the King of Siam. They arrived at the bar of the Menam on the 27th of September, 1687, having called in at the Cape of Good Hope for provisions, as did the previous expedition.

For the accommodation of these Jesuits, Phaulkon had proposed, as we have seen, to build dwelling-houses and observatories at Ayutia and at Lopburi. However the revolution which took place at the latter city in the following year, 1688, swept away Phaulkon and his scheme for the institution of the two observatories.

The instrumental outfit of the six Jesuit fathers, when they sailed from France in 1685, included

2 Quadrants of 90 degrees, 1 of 18 in.
1 „ 26 „.

3 Great Clocks, showing seconds.

An instrument to find at the same time the Right Ascension and Declination of stars.

1 Equinoctial Quadrant marking the hours to minutes, and which carried at its base a great needle to find at all hours the declination of the compass.

2 Half Circles divided very exactly (from six to six minutes) for Geometrical Observation, one provided with a sight rule and the other with a telescope.

1 Half Circle divided de trois en trois minutes.

2 Repeating pendulums.

Some burning mirrors (from 12 to 20 inches diameter).

Magnets, Microscopes.

Several Thermometers and Barometers.

Tubes and instruments for experiments in vacuo.

A clock for an inclined plane.

Two instruments of Romer, one representing the movement of the Planets, the other eclipses of the Sun and Moon.

Several books from the Royal Library.

To these must be added several telescopes of various lengths, which are referred to at different times but not mentioned catagorically.

Such a list could not fail to be of interest at the present time, and raises in one's mind the desire for a personal examination of the instruments themselves, to see the means whereby the fathers carried out those observations, the results of which have come down to us.

Tachard mentions that on the voyage out they sighted "l'isle de Fer," (Ferro), the most western of the Canary Islands, "where our Geographers have fixed their first Meridian." The longitude of Ferro is about 18°. 12'. west of the initial longitude at Greenwich, and it is no longer a matter of primary importance.

On the arrival of the two ships, L'Oiseau and La Maligne, at the Cape the Dutch Commandant kindly lent the Jesuits a house well suited for stellar observations, and they took the opportunity to obtain a better value for the longitude of the place by the method of occultations of Jupiter's satellites, using a clock marking seconds of time and an "excellent" telescope, 12 ft long. It was noted that the horizontal thread of the telescope was not quite parallel to the horizon, but care was always taken to allow for this by using the same part of the thread.

Using the Ephemerides of Cassini the Jesuits claimed that they improved the accepted value of the longitude of the Cape by nearly three degrees, as they found from their observations the difference between the longitude of the Cape and that of Paris to be one hour and 12 minutes or 18 degrees. In reality the difference is a little over 16°, but if, as stated by Father Tachard, the maps of the period showed the longitude of the Cape to be nearly three degrees too far to the East, the claim was quite justified.

Observations for Magnetic Declination, (Variation de l'Ayman) were made with an astronomical ring and gave 11½ degrees north-west as the result.

On the arrival of the Jesuits in Siam their time was at first occupied by ceremonies and functions, but early in December they were sent to Lopburi, where they were able to start some astronomical and magnetic work, and to prepare for the observation of an eclipse of the moon to determine the longitude of Lopburi.

Their proceedings are best given in Tachard's own words.

"When we had arrived at Louvo we began to make different observations, including all those we thought necessary for observing exactly the eclipse of the Moon which should take place on the 11th of December. We had not been able till then to use our instruments because all the time we were at Ayutia the City and the Camping places were so inundated that we had no place to set them up. The very house where we were lodged, being of wood, the least movement shook it so much that our Clocks and our Quadrants were disturbed.

The 6th and 7th of December we noted by the Astronomical ring of Sieur Butterfield that the magnetic variation was 26 degrees 20 minutes towards the West. This result remained constant during those two consecutive days.

The 9th of the same month by altitudes of the same limb of the Sun, the true time of noon by the seconds clock was 12 hours, 5 minutes, 3 seconds.

The variation of the compass by the parallactic instrument of Sieur Chapotot was found

one	time	16	minutes	only	
another	,,	31	,,	,,	Towards the
another	,,	35	,,	,	West
another	,,	38	,,	,,	

This variation was found by taking several times morning and evening equal altitudes of the Sun and observing each time the Azimuth, the needle remaining always on the North and South Line.

At the last Audience which His Majesty gave to the Ambassador he indicated to him that it would be very easy that we should make the first Eclipse in his presence. Some days after that Prince ordered M. Constance to inform us of the honour which he wished to do us. There was chosen for the purpose a Royal Dwelling, named Tale-Poussonnes, a short league from Louvo, towards the East, a little removed from the Forest where the King was at the Elephant Chase. M. Constance took us to inspect the place two days before the Eclipse. A more convenient spot could not be selected. We saw the Heavens on all sides and we had all the space necessary for setting up our instruments. After having settled everything we returned to Louvo.

On the following day, the 20th of December, by altitudes of the same limb of the Sun taken in the morning between 9 and 10 o'clock, and in the evening between 2 and 3, the true time of noon by the same seconds clock was 12 hrs. 2 min. 31 sec.

Variation of the compass by the Parallactic instrument,

one time	28	minutes.	
another time	33	,,	Towards the West.
another time	21	,,	

We will investigate in the future if the magnet of the Astronomical ring declines too much towards the West, as is very probable; for if that is so it will be necessary to deduct something from the variation of the Cape of Good Hope which we found to be 11 degrees and a half towards the West and the Pilots only about 9 degrees with their Mariner's needles.

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We caused to be transported to the Tale-Poussonne our telescopes and a spring clock very trustworthy and regulated by the Sun. For we had to observe there the Eclipse, according to the orders of the King.

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After having rested 3 or 4 hours we re-embarked to go to the gallery where we were to make the observation. It was then nearly three hours after mid-night. As soon as we had arrived we set everything in order.

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We prepared for the King a very long telescope of 5 feet in a window of a saloon which opened on the corridor in which we were. The Penumbra being well advanced the King was informed and came at once to that window. We were seated on Persian mats, some with telescopes, others with the clock, others ready to write the time of the observation. We saluted His Majesty with a profound bow, after which the observations were begun.

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The King expressed a special satisfaction in seeing all the spots of the Moon in the Telescope, and in seeing that the plan which had been drawn of it at the Paris Observatory agreed with it so well. He put several questions to us during the Eclipse. For example: Why the Moon appeared upside down in the Telescope ? Why one could still see the part of the Moon which was eclipsed ? What time was it at Paris ? What could be the utility of such observations made at the same time at two places at such a distance apart ? &c.

He wished to look through a telescope 12 feet long, which Father de Fontenay was using, and we immediately carried it to him. He allowed us to rise and stand up in his presence, and he was quite willing to look through the Telescope after we had done so, for it was necessary to put it in position in order to show it to him.

Those who know the respectful attitude which Siamese Kings expect from those who may be in their presence have spoken to us of this favour as of something very unique.

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RESULT OF OBSERVATIONS.

	Hrs.	Min.	Sec.
Total Immersion Louvo	4.	23.	45.
Paris by M. Cassini	9.	49.	30.
Difference of Meridians	6.	34.	15.
Commencement of Emersion Louvo	6.	10.	25.
Paris	11.	36.	18.
Difference of Meridians	6.	34.	7.
Difference of Longitudes	98°.	32′.	
Longitude of Paris	22°.	30′.	
Longitude of Louvo	121°.	02′.	

By the observations of the Eclipse of the Moon taken on the 21st of February, 1682, the longitude of Ayutia was found to be 121°, which agrees perfectly with these new observations. It is an astonishing thing that there are modern Charts which put the longitude of Ayuthia at 145°, whereas the great Chart of the Observatory, made before all these observations, gives it at 122°, only one degree different from these observations."

Perhaps the most interesting account of work done in Siam by the Jesuits is that of a visit paid by two of them, Fathers Visdelon and Bouvet, to a magnetite mine situated in the Chainat district. Their journey to the mine was made whilst Tachard was absent in Europe on his mission to obtain more mathematicians,

but the account of it appears in the second volume of his two works, published in 1689. The translation runs as follows:—

"The principal motive of this trip was to engage in the solution of this important problem: Whether the variation of the compass is caused by the unequal attraction of magnetic parts of the terrestrial globe.

We hoped that making several observations as we approached this mine, which, according to the report that has been given us, is sufficiently strong to produce sensible effects for a radius of 20 to 30 leagues around, we would find changes in the variation which could only be attributed to the different positions in which the needle would find itself with respect to the attraction on its poles, thereby allowing us to draw the general conclusion that all irregularities come from some such principle.

We were also of opinion that if one could once succeed in establishing this point beyond doubt, one would render an important service to the public in relieving it of the superfluous trouble which has long been taken in making observations to seek for a regular period of variations, which according to all appearances are not found in nature.

For whether the magnetic virtue which produces this effect is spread throughout the earth, which in consequence ought to be considered in this opinion as a great Magnet, even as Gilbert and the majority of modern writers maintain, or that this virtue resides only in Magnetite Mines, which appear on the surface of the earth, or which are hidden in its breast; it is unquestionable that the variation, by an absolute necessity, will always follow irregularities, which arise from the different alterations which the parts of the earth, or, if you will, Magnetite Mines, of which it is full, receive at different times. So that as this would be a bold enterprise, to wish by dint of observations to confine in the limits of a regular period the inequalities of changes which are produced in the earth, by that multitude of causes which its depth hides from our eyes: so we could well say that one would worry oneself in vain to pretend to bring under rules the effect of so many causes which do not have rules.

Astrologers would succeed sooner in predicting the future by stars, of which after all the combinations are limited, and the orbits regulated, than Geographers in making the change which in the future should come about in the yearly variation on each point of the earth's surface, by tables as certain and exact as those of eclipses, since the causes on which the variations depend are capable, by their multitude, of receiving an almost infinite number of combinations of which each would pass for an Anomaly in the circulation of the effects of each particular cause. For, as this combination is only formed by the fortuitous concurrence of extraneous causes, which disturb the natural sequence of effects of the ordinary phenomenon, and which might perhaps never find the end of their revolution, continuing always to suffer interruption from others, the world would come to an end before they have had time to return to the point whence they set out, (I wish to say), to the same state in which they were when God first gave them their first impulse at the beginning of the world.

We now come to the observations which the trip allowed us to make on this subject, leaving each one to draw his own conclusion in favour (or otherwise) of the opinion which has been indicated.

The Instruments used were a large Astronomical Ring and a small half circle, which had given us at Louvo 4° 42′ of variation N. W.

We set out from Louvo on the 18th January (1687) with Mr. de la Mare, Engineer of his Very Christian Majesty, whom the King of Siam sent to lay out certain fortifications. We went by the river, which we ascended as far as In-buri, a small market-town, remarkable for the junction of 3 great roads leading to the Kingdoms of Pegu, Lao, and Cambodia, where we arrived after mid-day on the 19th. Whilst Mr. de la Mare selected a suitable spot to lay out a fort of 50 toises a side in extent, we occupied ourselves in taking the variation which we took several times, all our observations giving constantly at least 7°. 30. N. W. The needle of the small half circle showed it to be a little more, but this excess could be set down to the fact that we could not place its compass parallel to that of the Ring, not being able to detach it as was necessary for this purpose. For this reason we, thereafter, only made use of the large Astronomical Ring.

On the morning of the 20th we measured the width of the Menam opposite the great road of Cambodia where the fort is to be erected. We measured one side of 45 toises which gave us an angle of 65° 24′ and for the width of the river 98¼ toises. After that we mounted on Elephants to go to the place where the King of Siam wished Mr. de la Mare to place a fortress 300 toises long by 200 wide to oppose the Cambodians, Laos and Peguans in case of an insurrection. This place lies at East ¼ South East of In-buri at some 2,000 toises distance. We found there 9° of variation to the N. W.

Hardly had we returned than we had to re-embark at 5 o'clock in the evening to go to the mine.

Before setting out they warned us to look for crocodiles which are in great number in this part of the river. In fact on the following day, the 21st, at 7 in the morning in the space of a short league a little below a small village called Talat Kao we saw everywhere fresh signs which these beasts had left on the bank on which they dragged themselves, and the marks of their claws were imprinted on the banks where they crawled amongst the reeds which border the river.

At 10 o'clock we landed at Ban Kie-biane where we found no variation. At 3 in the afternoon we arrived at Chainat-buri.

Chainat, if the Siamese are to be believed, has been at one time a considerable Town and the Capital of a Kingdom. To-day it is a colony of 2,000 to 3,000 souls, according to the report of the country folk. Its situation is very agreeable, on the banks of the Menam, which is here very wide and shallow. We measured the width with the half-circle and found it more than 160 toises. We found there at least 40° of variation N. W. The mountain Kao Lem, behind which is the magnetic mine, is to the N. E. ¼ E., a little to the north, as one sees it in the small map made on this trip.

On the 22nd we travelled by land. We came to a village which is 6,000 or 7,000 toises from Chainat due North. It is situated between two mountains at the foot of that named Kao Keiai, from which it has taken the name of Ban Keiai; we found there 50° 30′ of variation.

From there setting out to the N. E. some 6,000 toises we slept at Lompeen, a small village of 12 or 13 houses on a lake of the same name. This lake is 200 sen long, following the reckoning of the Siamese, which comes to 4,000 of their toises which are a little less than ours. It sustains fish and and crocodiles. Formerly it had a town on its banks which the Siamese say was the capital of a kingdom which their kings have conquered; there are still some remains of ramparts there.

On the 23rd, after having travelled 6,000 or 7,000 toises towards the East, we came to the village of Ban-soun, composed of 10 or 12 houses. The neighbourhood of this village is full of iron mines. There is there a wretched forge where each of the inhabitants is compelled to cast a picul, that is to say, 125 lbs., of iron for the King. The works consist of 2 or 3 furnaces which they fill up, after which they cover the charcoal with the mineral, and the charcoal burning away little by little the metal is found at the bottom in a kind of round mass. The blast apparatus used is very curious. It consists of two hollow cylinders of wood of which the diameters are about 7 or 8 inches. Each cylinder has its wooden piston surrounded by a piece of wound cloth which is attached to the wooden piston by string. A single man raised on a small chair, if it be necessary, takes one of these pistons in each hand by a long handle to lower and raise them one after the other. The piston which he raises allows the air to enter, because the top of the cylinder is a little wider than the lower part and upon being lowered forces the air under pressure into a bamboo tube leading to the furnace.

We found near this village 4° of variation to the N. W. From there we went to sleep in the jungle 3,000 toises from the mine or thereabouts at the foot of a mountain shaped like a sugar loaf, from which it is named Kao Lem. We found at this spot 2° of variation to the N. W.

On the 24th we set out early to go to the mine.

This mine is to the west of a fairly high mountain called Kao Pat Ka Dek, to which it is almost joined, so close are they together. It appears to be divided into two rocks which apparently are united under ground. The larger in its fullest length,

which stretches from the East to the West, is about 20 or 25 geometric paces and 4 or 5 in width from south to North. At its greatest height it is 9 or 10 feet. It shelves a great deal and is very rugged. The small one, which is to the north of the larger one, from which it is distant only 7 or 8 feet, is 3 toises long, and is neither high nor wide. Its magnetic force is higher than the other. It attracts with an extraordinary force the iron instruments which we used. We made every effort to break and pull away a piece of the iron rock but to no purpose, our iron tools which were badly tempered being immediately bent; all splits made with them in the rock were at once closed up by the magnetic force. We were thus obliged to try and secure a sample from the larger rock of which we could only, with great trouble, break some pieces jutting out and which gave some hold to the hammer. We did not fail to get some good pieces, and there is no doubt that good specimens are to be found by excavating a little in the ground. The poles of the mine, as far as one could judge from the pieces of iron applied to it, faced South and North, for one could learn nothing from the compass, the needle varying so much as one approached it. Here is what was observed touching the variation. The first observation was made at the W. N. W. of the large rock, at 10 geometric paces distant, if, however, the mine does not extend very far under the ground. We found 10° variation to the N. W. To the North of the same rock towards the middle at 3 or 4 paces we found no variation. To the E. N. E. of the rock at 12 geometric paces we found more than 80° of variation to the N. E. And 4 or 5 paces farther to the E. the variation diminished by more than 30°. At E S. E. of the rock at the same distance as before we found only 40° of variation to the N. E.

These observations were made hastily. Want of provisions and the presence of wild beasts obliging us to a hasty return to Lompeen where we found on our return 6° of variation to the N. W. But there is some reason to believe that the mine effected some change in the needle, for on the following day when passing through Bankeiai, we found 2° of variation less than we had found before.

Some instruments were left for the Fathers who are expected here; they will be able to make use of these for another trip when they can make observations with greater precision and success. "

The magnitude of the problem which the Fathers set themselves to solve by their observations on this trip was quite out of proportion to the results obtained, but those results are by no means without their utility. When a topographical survey of the Chainat district has to be made, it will be useful to know beforehand that the compass is not to be relied on in that district, and indeed it will be of general advantage to continue, as it were, the Fathers' investigations, in order to define properly the limits of the region within which erratic or anomalous variations of the ordinary declination of the needle take place.

On arrival at the Cape on his second voyage to Siam Father Tachard and his companions made use of their opportunity to carry out further investigations. A fresh determination of the difference between the longitudes of Paris and the Cape was made and he remarks that good marine charts put the longitude of the Cape at 37 degrees or thereabouts, so that the charts had improved since his first voyage, the true longitude of the Cape, with respect to Ferro, being about 36°. 41'. Father Tachard also took some notes on the tides and observes that with a north wind blowing one observes no reflux, while with a south wind the sea mounts to a prodigious height and does not go down. The declination of the compass was found to be 8°. 40′. north-west, while the value used at that time by the local pilots was 8°. 30′. It was intended to observe for magnetic dip, on behalf of the Duc de Maine, but the instrument for measuring it was not ready to be put on board when the ships left Brest.

With regard to the latitude of the bar of the Menam Tachard remarks that nearly all the Marine Charts they had seen put the bar at 13°. 45' north, but as they had found the latitude of Lopburi to be 14°. 42′. 30″ while Father Thomas had found that of Ayutia to be 14°. 18′ ; that of the bar therefore should be a little less than that given by the charts.

The present accepted values of the three places just mentioned are as follows :

Bar	13.	25.	0.
Lopburi	14.	48.	17.
Ayuthia	14.	20.	57.

It will thus be seen that Tachard's inference as to the latitude of the bar, though based on incorrect premises, was true.

The foregoing pages contain all that is to be extracted from the two volumes of travels published by Father Tachard. It must be admitted that the results in quantity do not amount to very much, but this would hardly be the right way in which to weigh them. At the time when the observations were made they furnished values which were, no doubt, acceptable and accepted as the best available for use for the construction of charts and for navigation purposes. From an historical point of view the fact that the observations were taken at all, and the circumstances surrounding them must always remain of interest, especially to those connected with Siam and concerned in any way in its past, whilst allied to this aspect of the case lies the possibility or power, which has its utility to a surveyor, to institute comparisons between the results obtained then and those of a later date. No doubt other observations than those set down in the two volumes were made by the fathers, for there must have been plenty of spare time for such work. This opens up a question which perhaps some member of the Siam Society might take in hand, the question, namely, of endeavouring to discover, if the Society of Jesuits would permit, whether they have amongst their archives any papers which contain the records of work done in Siam by their members in olden days, bearing on the subject of this paper, and of which copies may be taken.

It may be stated that to an observer the comparison of results conveys no idea of disparagement of any of the observations, of whatever date, provided it is assumed that the best results obtainable from the instruments used have been secured, and it might well be more generally understood that the work of comparison is always going on in some form or another in survey work of this description. A latitude or longitude value may be said to be good and useful till it is improved upon and superseded by a better value, but it does not follow that the first value, when set aside, may be underrated, for it has served its purpose, and still affords a measure for estimating the progress or improvement which should constantly be sought for, whilst any better results are obtainable, in a practical sense.

In conclusion, let it be said, when considering the work done in the past by the Jesuit Fathers in all quarters of the globe, (I refer of course to their scientific work outside any efforts in propagating the gospel), and admiring the results achieved in the face of difficulties and adverse conditions, to any one who takes interest in the historical point of view previously referred to it must be a source of satisfaction that there were found men ready to risk and to endure the hardships certain to be met with in order, as we have read above, that they might "establish Security in Navigation and improve Sciences and Arts." It is only quite recently that Geography has been universally elevated to the dignity of a science and its study and teaching formulated in a manner befitting the subject. In the annals of that science the Jesuits who travelled to the East, and some of whom worked in Siam, will assuredly have their place.